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The Journal of HEREDITY

A monthly publication devoted to Plant Breeding Animal Breeding and Eugenics

A KENTIA PALM OUTDOORS IN CALIFORNIA

Twin and Triplet Birth Ratios
R. L. Jenkins

Altering a Genetic Character
Robert T. Hance

SEPTEMBER, 1927 Vol. 18, No. 9

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CONTENTS

ALTERING A MATURED GENETIC CHARACTER.....R. T. HANCE 377

POSSIBILITIES OF HYBRID OAKS.....H. NESS 381

TWIN AND TRIPLET BIRTH RATIOS.....R. L. JENKINS 387

KENTIA PALMS IN CALIFORNIA.....O. F. COOK 397

AGRICULTURAL RESEARCH AND EXTENSION..... 419

HERITABLE CHARACTERS OF MAIZE.....M. DEMERC 421

BRIEF REVIEWS AND COMMENTS

A SELECTIVE TURNOVER AMONG BRITISH FARMERS..... 394

ORIGIN OF DOMESTICATED ANIMALS..... 395

AGRICULTURAL RESEARCH AND EXTENSION..... 419

PEYOTE INTOXICATION..... 422

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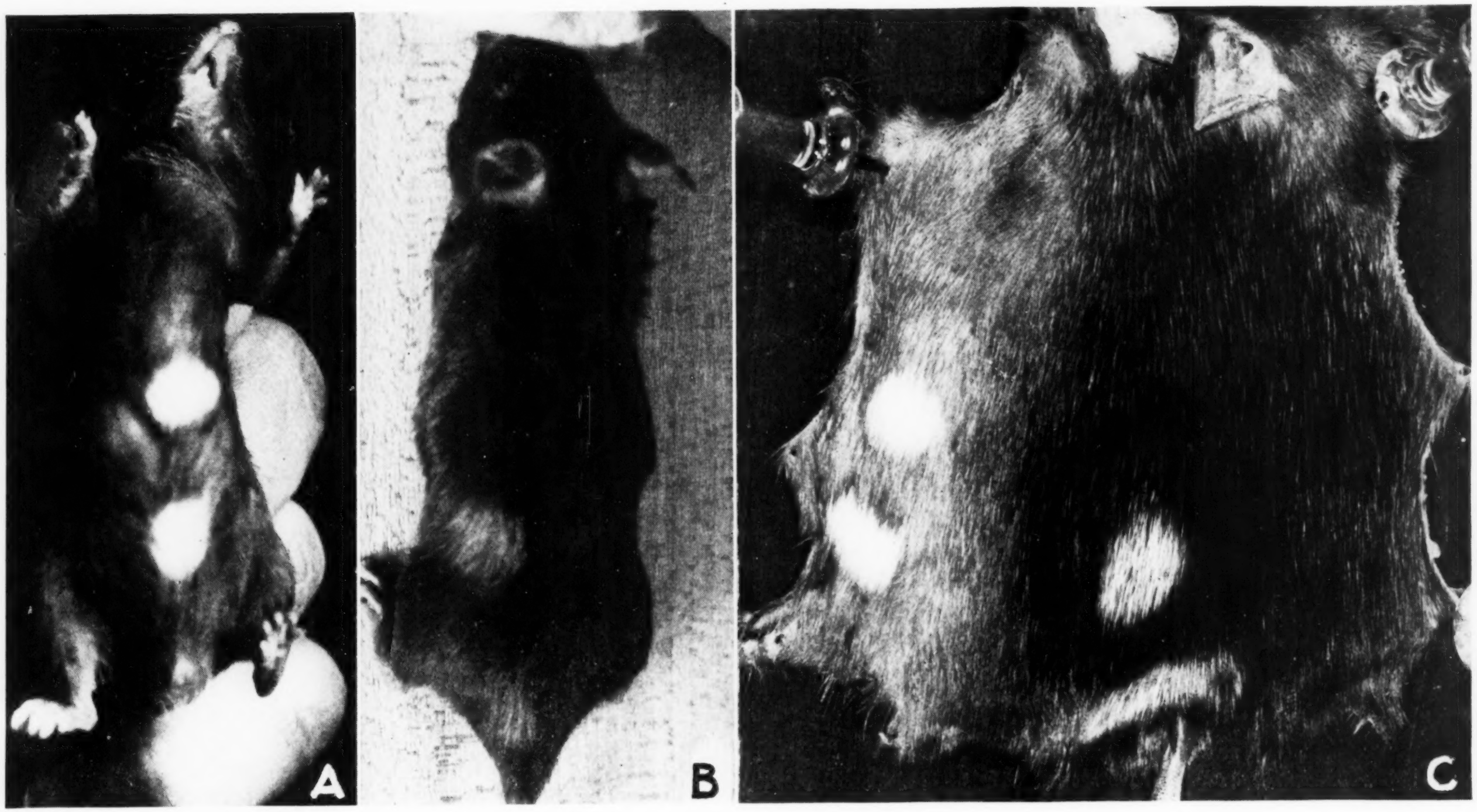


DEPIGMENTATION BY X-RAYS

Frontispiece

A—The two whitened areas on the abdomen of this black mouse were the result of exposure to high voltage X-rays for a period of ninety minutes. A rubber and lead shield protected the animal except in the region of the two white spots. The original hair in the region of exposure dropped out in about ten days and the new hair that replaced it was pure white. The new hair had made considerable growth in about one month. *B*—The same mouse shown in Figure 1 viewed from its dorsal side. The whitened areas here correspond to those on the abdomen but are less intense, due to a mixture of dark and white hairs. The posterior spot is not symmetrical as the skin of the back at this point was partly shielded by the bones of the pelvic girdle. These areas did not appear for nearly three months. *C*—The skin of the mouse shown in *A* and *B* stretched to show the relation of the spots on the abdomen and back—From the *Journal of Experiment Medicine*, vol. 44, 1926.

ALTERING A MATURED GENETIC CHARACTER

ROBERT T. HANCE

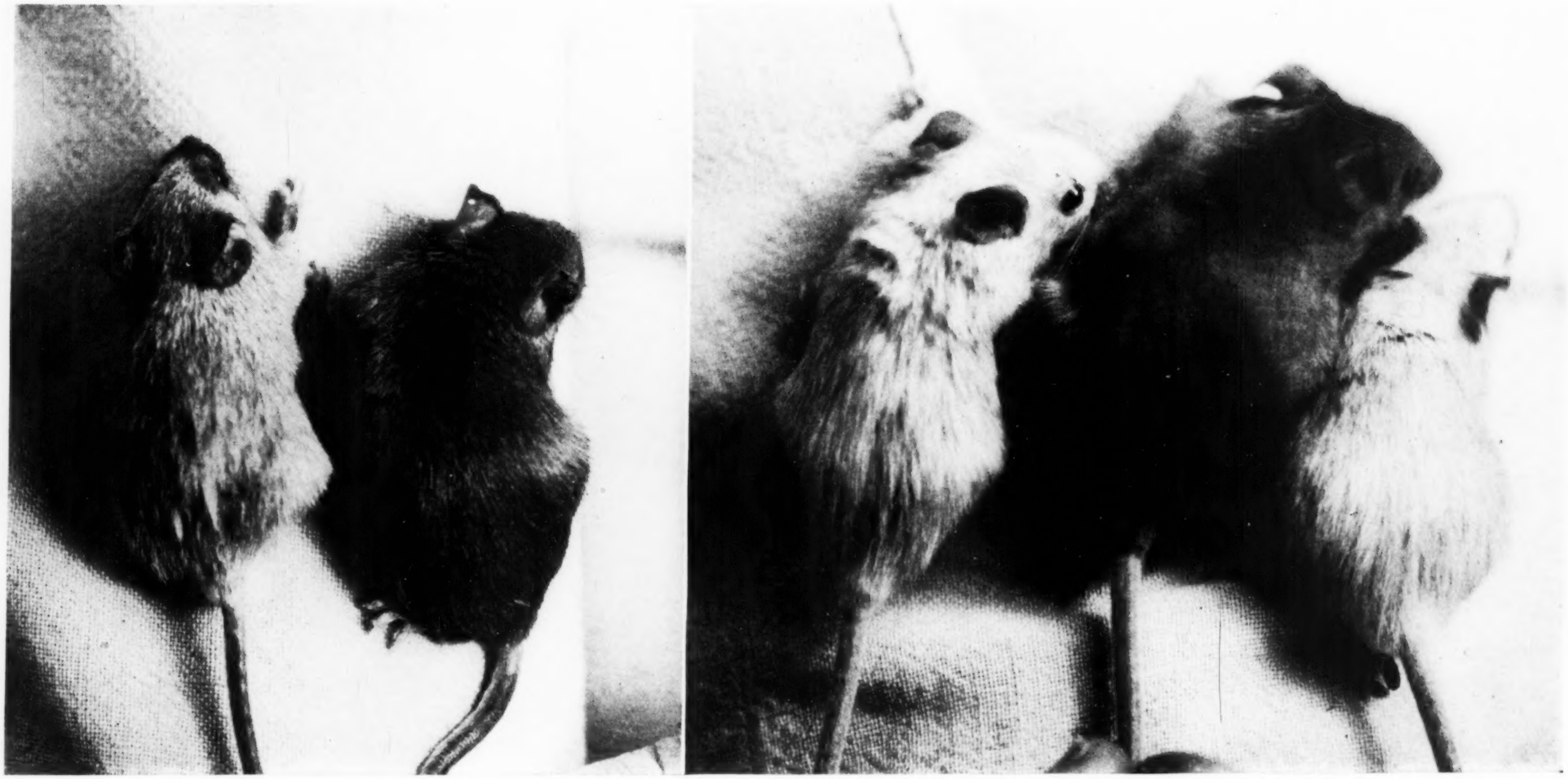
The Rockefeller Institute for Medical Research and University of Pittsburgh

MAN has never been satisfied to accept as final the verdict of Nature in regard either to his own inherited characteristics or to those of other living things and is ever trying to alter them in one way or another. If it seemed worth while to become philosophical about this human penchant, it might be argued as having its roots in at least two instincts—the one commercial as related to the increased value accruing to whoever effects profitable improvements in domestic plants or animals, and the other, the purely personal, bearing on the betterment of the anatomical and physiological shortcomings of man himself. The latter attempts, of course, range all the way from surgery and medication to the superficial administrations of the so-called beauty culture.

It is, perhaps, needless to point out that a change or an improvement in somatic characters was not the motivating factor in this investigation. As a part of a general program dealing with the biological effects of X-rays, it was found that a few weeks after mice with pigmented hair had been exposed to certain amounts of X-rays their colored hair fell out and was replaced with white. This process took about four or five weeks, and since the white hair has, so far, persisted for twelve months without any indication of change, it may consequently be considered a permanent reversal of the original genetic character. In the first experiments only small areas (See Frontispiece) were exposed to the X-rays, as it was found that the adult mouse could not tolerate over its entire body the length of exposure then used and live. An interesting side issue of these general observations is brought out concerning the delayed action of X-rays when whitened areas appeared on the side of the mouse opposite or underneath the one directl exposed long after the appearance of the first spots. As has been pointed out, it took approximately a month for the white hair to make its appearance on the belly, which was the region first treated. Three months after the exposure it was noticed that areas on the back or dorsal side of the animal that had been directly under the exposed belly, were beginning to whiten. All the hairs of this new decolorized spot did not become white, as the force of the rays was, of course, much diminished by passing through about a half inch of tissue that separated the two regions. There was, however, about an equal mixture. I have thought that there was some tendency for the rays to decolorize certain types of hair(the mouse has at least two grades of hair, the very fine, or fur, and the coarser hair) and not the others, but I have been unable satisfactorily to demonstrate this.

In any case, enough of the nature of hair pigmentation has been worked out by the chemists to indicate that the coloration can be described in chemical terms and is obviously subject to the ordinary laws of chemical reactions. It is then clear that in changing the normal hair color X-rays have in some way broken up the chain of chemical reactions. Since this interference has occurred in a chemical system of which something is already known, it is hoped that it may serve through further analysis, as a lever that may aid in prying open at least one phase of the

but are less intense, due to a mixture of dark and white hairs. The posterior spot is not symmetrical as the skin of the back at this point was partly shielded by the bones of the pelvic girdle. These areas did not appear for nearly three months. C—The skin of the mouse shown in *A* and *B* stretched to show the relation of the spots on the abdomen and back—From the *Journal of Experiment Medicine*, vol. 44, 1926.



PROGRESSIVE EFFECTS OF X-RAY TREATMENT

Figure 1

Left—These two mice are from the same litter of pure bred agoutis. The lighter colored one was exposed for ten minutes to low voltage X-rays when it was about two weeks old. It can readily be seen that it is smaller than its darker sister. While otherwise apparently normal they are more nervous and wilder than the unrayed controls. *Right*—These animals are from the same litter illustrated on the left, but were photographed when a few weeks older. The effect of the radiation in whitening the hair is obviously becoming more pronounced as the animals grow older. This picture was taken two and a half months after the mice had been exposed to X-radiation.

HALF HIS COAT TURNED WHITE

Figure 2

The picture of this mouse was made about a year after it was exposed to X-rays. It was intended to produce on this animal's back the letters R. I. as a demonstration of the perfect protection of the rubber and lead shield except where the letters were cut from it. The shield slipped during the exposure and the whole fore end of the body received the effect of the rays with the obvious results. A portion of the letter R and the entire letter I are visible. This mouse was exposed for ninety minutes to high voltage X-rays.

secret of the effect that X-rays exert on living substance.

A further study of exposures has brought out that, although adult animals cannot withstand a general subjection to X-rays given for longer periods, they will survive the effect of exposures of similar duration when a portion of the body is shielded (Frontispiece, and Figure 1). Also, although newborn mice are easily killed with relatively small doses of X-ray, when 10 or 15 days old a relatively small exposure to X-ray will turn the hair white without injuring the animals in any other way, although they may be slightly stunted in size as compared with control animals from the same litter (Figure 1).

Is the Change Inherited?

The lighter colored mice in Figure 1 would scarcely be taken for litter mates (from a pure agouti cross) of their companions. The agouti character has been changed beyond recognition except in small areas that were more or less shielded by their location from the direct effect of the rays. The change is known to be permanent. The rather fascinating question now suggests itself as to whether or not this alteration in this superficial and acquired character may be hereditary. It would seem highly improbable that the factors for hair color in the germ cells would have been changed simultaneously and in the same way as the already developed genetic character, but X-rays do some queer things and it is worth investigating. The other animals that were given long exposures were all sterilized and the younger ones are only just reaching sexual maturity and have still to demonstrate their potency. It is to be hoped that the lightness of the treatment they received may not have harmed their reproduc-

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X-radiation.

tive power, for while it is quite likely that eventually we shall have to record another bit of evidence against the theory of acquired characters, still, considering the method of producing this acquired character, the attempt at experimental breeding is entirely justified.

Causes of the Change

What is it that has happened to the hair and pigment producing centers of the skin to cause them to lose their ability to produce the pigment that originally was their heritage? We may at least hazard a guess, even though it may have to be retracted later. Even a wrong guess may suggest the right answer to some one, if for no other reason than by arousing his indignation over the intellectual inadequacy of its originator.

One of the theories that seems best grounded holds, in its simplest form, that at least two factors are concerned with pigment or melanin formation. The first is a color base or chromogen, which is without color. The second is the activator or enzyme that reacts with the chromogen to produce melanin. This enzyme is an oxydase and is considered to oxidize the color base. The latter is called tyrosin and the former tyrosinase. One without the other forms no pigment. If neither is present no pigment is formed, which would be the case in the recessive albinos.

What has the above to do with our X-ray results? Since pigmented mice became white after exposure to X-ray it is reasonable to suppose one of the two factors involved in melanin production, either the chromogen or the oxydase, was effected and probably eliminated. Since changes in other enzymes have been reported it is easier to believe that such has been the case here. Preliminary histological examination of the whitened areas tend, to some extent, to bear out this suggestion as pigment granules which, presumably, represent the chromogen are present in the affected hairs, just as they are in the colored areas. The fully developed whitened hairs clipped from the coat of the X-rayed animal shown in Figure 2, however, show no variation from normal albino hairs, and so far I have been unable to correlate the two observations. (These granules are not found in the hairs of the albino mouse.) We can carry this logic still farther and point out that it is more probable that the source of supply or of the manufacture of tyrosinase is the thing killed by the X-rays rather than the enzyme itself, or else the color would return to the whitened areas with the formation of fresh enzyme. Whether the latter is true or not, and it must be admitted that it is based on very little real evidence, another point seems more certain. The cells of the hair follicles reproduce with fair activity with the consequent replacement of the cells originally affected. Unless the change induced by the X-rays was passed on, somatically inherited, we might expect the colored areas to return eventually, which, as has been shown, does not happen.

And so here we shall have to leave the results hanging. A permanent change has been produced in a matured genetic character by means of X-rays. It is believed that this change is the result of the inhibition or actual killing of the part of the cell concerned with the manufacture of the enzyme needed in the production of color. Since the new color, or rather lack of color, is permanent, it follows that the alteration is passed on to the cells that replace the ones that first encountered the X-rays.

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POSSIBILITIES OF HYBRID OAKS

Further Observations on Hybrid Oaks at College Station, Texas*

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THE A & M. College of Texas is located in Brazos County on what is known as the Lufkin series of soils. The forest flora in the immediate vicinity is very poor in species, consisting for the most part of Post Oak (*Q. minor*, Sargt.), and Black-jack (*Q. marilandica*, Muench); but along the water courses, Water Oak (*Q. nigra*, L.) is frequently met with. What now constitutes the college campus was formerly an open prairie of about two hundred acres in extent.

In 1891, a few individuals of the Live Oak (*Q. virginiana*) were planted on the lawn of the main building and on the lawns of two or three other buildings grouped near it. As the institution grew, new avenues were opened up leading away from the central group of buildings; and as these avenues were extended, more Live Oaks were planted. All the subsequent plantings are descendants of the first, ranging from the first to the third generation of those planted in 1891. Many of the later plantings have been made at a distance of a hundred rods or more from the original mother trees, and in positions where the prevailing winds and obstructions of new buildings would preclude, or greatly reduce the chances of any pollen reaching them from the trees of the first planting.

The Live Oak commences to bear female flowers at about five years after planting on this soil, but no male flowers are produced until several years later. Yet, the female flowers on these young trees, apparently beyond the reach of pollen from their own species, fail but rarely to produce an ample crop of well developed acorns.

The gardener in charge of the campus has raised several hundred trees in his nursery from acorns, many of which have been gathered from the young Live Oaks bearing female flowers only. Owing to their impure parentage, these seedlings developed a great diversity of forms as they grew. A third or more of them exhibited all graduations from apparently pure Post Oaks in every organ, to Live Oaks with leaves having suspiciously deeply dentate margins. The texture and the tinge of color of the leaves were in some characteristic of the Post Oak; while their forms, varying greatly, even on the same individual, and would, in some cases, appear foreign to that of the leaves of either parent. It is likely that a great many more of these nursery trees were hybrids, but developed no characters in the first generation to distinguish them from the pure Live Oak mother.

We have also on our campus seven individuals of the first generation of Overcup (*Q. lyrata*) as pollen parent crossed with the Live Oak as pistil parent. This cross is due to artificial pollination made in 1909 and 1910.* The trees have now attained perfect fruiting maturity. All of them have, during the last two years, borne a profusion of both female and male flowers; and six of them have for several years matured increasing crops of acorns. The seventh, which first bore male flowers, has continued to bear them in a greater profusion than any of the others, but it has matured no fruit, although female flowers ap-

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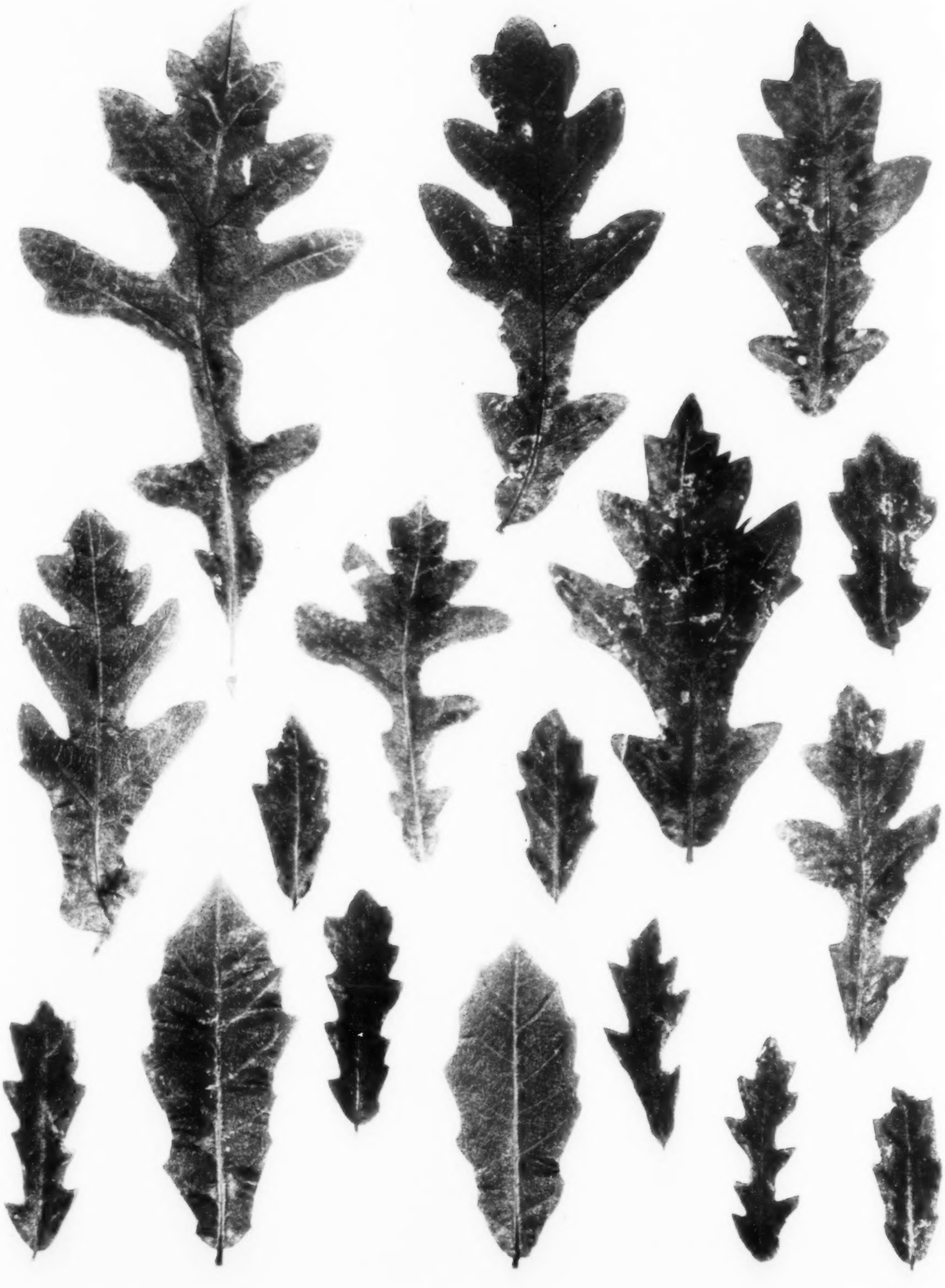
LEAVES OF LIVE OAK—POST OAK HYBRIDS

Figure 3

Twigs from two different trees of a cross of *Q. minor* ♂ *Q. virginiana* ♀ showing the diversity of the foliage characters.



LEAVES OF OVERCUP—LIVE OAK HYBRIDS

Figure 4

Each leaf is from a different tree, and the plate gives an excellent idea of the extent of variation in size and shape of the leaves.

LEAVES FROM A SINGLE TREE

Figure 5

The leaves from a first generation hybrid of the live oak and post oak, showing the amount of variation in size and shape.

parently normal are produced in abundance every year.

Their leaves are intermediate to those of the parent species in all characters. The erect position of the shoots and the general outline of the trees are, however, characteristic of the Overcup Oak, but the fruit is typical of the Live Oak, showing no traces of the Overcup parent.

A goodly number of trees of the second generation from this cross has been obtained. Twenty of these were planted in the arboretum of the Experiment Station in 1923; others had previously been planted in other places. But in this, the second generation, a great diversity of characters occurs; and like the first generation of Post Oak × Live Oak, the variations seem to take all shades from an intermediate blend of Overcup and Live Oak characters to forms not to be distinguished from either, and some in which the characters of neither parent can be pointed out by one unaware of their origin.

One individual of this second generation, planted in 1920, bore acorns in 1923. In 1925, it bore also many male catkins and set a good crop of acorns. This year, 1926, the abundance of both male and female flowers was increased, the proportion of males to females was normal, and the crop of acorns was very heavy. Owing to a severe wound inflicted on the trunk of this tree by an automobile about three years ago, its growth has since that time been retarded. This may account for its early and great fertility. A few of those in the arboretum from the same generation bore acorns this year, but no male flowers were noticed.

In spite of two droughty summers, the inclement soil, and the weeds, due to non-cultivation during the same length of time, these twenty trees have done uniformly well. Only one shows sign of disease, while the others added twenty to thirty-six inches to their height during the season. The general form of outline of the growth in these trees simulates the F_1 generation and that of the Overcup Oak, irrespective of the type of foliage and twigs. The tall, straight trunk with the principal branches ascending, is exhibited as much by those having leaves of the Live Oak type as those with leaves like the Overcup Oak.

This is an improvement on the Live Oak, the trunk of which is generally too low and the branches too spreading for avenue trees, as well as for timber. Since a tall and erect growth is a dominant factor in the hybrids between the Overcup and the Live Oak, it may be assumed that this character would be still further enhanced in hybrids between the White Oak and the Live Oak; because the bole of the White Oak is the least deliquescent of all our native oaks, being in that respect, when growing in dense stands, similar to the pines.

These twenty trees of the second generation of Overcup-Live Oaks may be estimated, if classified according to the type of their foliage, to fall roughly into the following groups:

7 *Q. lyrata* type.
5 *Q. virginiana* type.
6 intermediate.
1 indeterminable.
1 *Q. minor* type.

The reason for the last, or the Post Oak type, is very plain, when it is remembered that the parent tree (F_1) were of incomplete maturity, bearing but a very few male catkins, at the time they produced the acorns which gave these trees of the second generation. It is, indeed, to be expected that some of the other are also due to Post Oak pollen, but that this is obscured by the dominance of the Overcup-Live Oak combination,—consequently, may become apparent in any future generation.

Post Oak Hybrids

Planted on the same ground and at the same time (March 1923) as those just described are two trees of Post Oak × Live Oak (F_1), due to artificial pollination, and two other trees,

Post Oak × White Oak (F_1), which are natural hybrids.

The seeds of the latter cross were picked from a matured White Oak planted in the proximity of several Post Oaks. Their hybrid origin was readily discovered in the nursery, since the Post Oak characters were very evident in both the foliage and the shoots. The growth, however, is stronger and cleaner than in the Post Oak of the same age, which in its youth is generally short and scrubby with the foliage stunted and distorted by gall insects.

The Overcup Oak makes a very poor growth in this soil. The largest of those planted twenty-five years ago are now less than twenty-five feet tall and show already signs of senility; while three Overcup-Live Oak hybrids of the first generation planted in 1912 are over thirty feet tall with a trunk diameter of corresponding dimensions.

The two Post-Live-Oak trees are of different types. In one the Post Oak is dominant in leaves, twigs, and bark. In this individual the leaves were dead December 16, though still hanging to the twigs as on the Post Oaks of the neighboring woodland. On the other, the leaves were alive and otherwise characteristic of the Live Oak. The increase in height of these two trees for the season is about three feet for the first, and twenty inches for the second.

From artificial pollination made April 3,1918, we have three specimens of *Q. platanoides* (male) and *Q. virginiana* (female) in the arboretum of the Experiment Station. They were planted in 1920. One of them produced a few acorns in 1923. This year, 1926, all bore heavy crops of acorns, although no male flowers were produced. They are very uniform in characters, strongly resembling *Q. platanoides;* the only difference being that the leaves are somewhat smaller, more persist, firmer, and the crown more densely branched than in *Q. platanoides.*

Economic Advantages of the Live Oak Hybrid

As already stated, the forest flora of our immediate locality is very poor in species; and the soil, being unfavorable to forest growth, makes it extremely difficult to find species that will make a moderately thrifty growth, or endure for a reasonable number of years.

Out of the considerable number of species of forest trees tried, the Live Oak has shown the greatest adaptability and endurance. This may be accounted for, when we observe that its natural habitat ranges from the low alluvial flood plains along our rivers to the dry crevices in the limestone rocks of Edwards Plateau. In the first situation, it becomes one of the largest trees in the South. In the second, it is reduced to a shrub, no taller than a man; but in both places, its adaptation seems to be perfect and its longevity very great.

The indications observed on this soil are to the effect:

1. That hybrids descended from the Live Oak, as mother, are of a stronger growth, in both the first and the second generation, than either of the parent species.

2. That they are fertile at an early age, in both F_1 and F_2 generations they produce seed of normal viability.

3. That the first generation, while very variable in some combinations, is uniform and intermediate to the two parental forms in other combinations; but this uniformity is followed by the segregation of characters in the succeeding generations.

4. Because of the ease with which the hybridization of the Live Oak may be effected, the high fertility of its hybrids and other virtues already mentioned, to which very likely may be added improvements of the timber; there can be no doubt, but that the breeding of new forms of oaks, as here indicated, has great economic and aesthetic possibilities.

TWIN AND TRIPLET BIRTH RATIOS

The Inter-relations of the Frequencies of Plural Births

R. L. JENKINS*

IT is an axiom in scientific investigation that the introduction of quantitative methods, which permit the accurate checking of theory against empirical fact, is generally followed by a rapid growth of knowledge. Of late years much attention has been directed to the application of quantitative methods to the study of twins, with a view to investigation through this channel the laws and phenomena of heredity. One phase of this study has perhaps been neglected—the quantitative study of the inter-relationships of the frequencies of plural births, which may possibly throw new light on the phenomena of twinning.

In 1895 Hellin developed the rule that twin births occur in the ratio of 1:88, triple births in the ratio $1:88^2$ and quadruple births in the ratio $1:88^3$. The rule is perhaps better stated in the form that if twin births occur with a frequency P, triple births occur with a frequency P^2, and quadruple births with a frequency of P^3. The actual findings of various investigations are shown below.*

The agreement, as will be seen at a glance, while not perfect, is approximate. Hellins' law has received general acceptance as a *first approximation.*

It has long been known that the frequency of twin births varies greatly with the age of the mother, increasing gradually up to a peak between the ages of 35 and 40, and then falling off. Table I and Figure 6 give some statistical data from Finland, Denmark, France and the United States Birth Registration Area illustrating this fact.

Relations of One=egg and Two=egg Twinning

In regard to the relative frequency of monozygotic and dizygotic twins, various investigations have found the proportion of twins which were monozygotic from 20 per cent to 30 per cent, 25 per cent being about average. The same result is obtained by the use of Weinberg's differential method.

Weinberg's method is based upon the assumption that in the case of dizygotic twins, the sex of each twin is determined independently of that of the other. If then the probability of a boy developing from a fertilized egg is $.5 + a$ (because of the slightly greater frequency of male births), the probability of a girl developing from a fertilized egg will be $.5 - a$, and the probability of dizygotic twins being opposite-sexed will be twice the product of these two probabilities, or $.5 - 2a^2$.

Weinberg considers the $2a^2$ so small that it may be disregarded, and the formula for practical purposes resolves itself into the form that half of the dizygotic twins will be opposite-sexed. Since all the monozygotic twins are same-sexed, it should be possible then to determine the number of monozygotic twins in any given group by subtracting the number of opposite-sexed twins from the number of same-sexed twins. The difference should be the monozygotic twins.

***Twin and triplet birth statistics.**

	Number of Births	*Twin birth ratio*	*Triplet birth ratio*	*Quadruplet birth ratio*
Veit Prussia 1826-1849	13 million	1:89	$1:89^2$	$1:71.9^3$
Neefe 1877	50 million	1:82.7	$1:80^2$	$1:82^3$
Prinzing 1892 Germany 1871-80	63 million	1:85.6	$1:84^2$	$1:92^3$
Rupen 1901 Prussia 1890-99	12 million	1:80	$1:86.6^2$	
Guzzoni	50 million	1:87	$1:84.3^2$	

*This is one of a series of articles published by members of the staff of the Illinois Institute for Juvenile Research. Series C, No. 118.

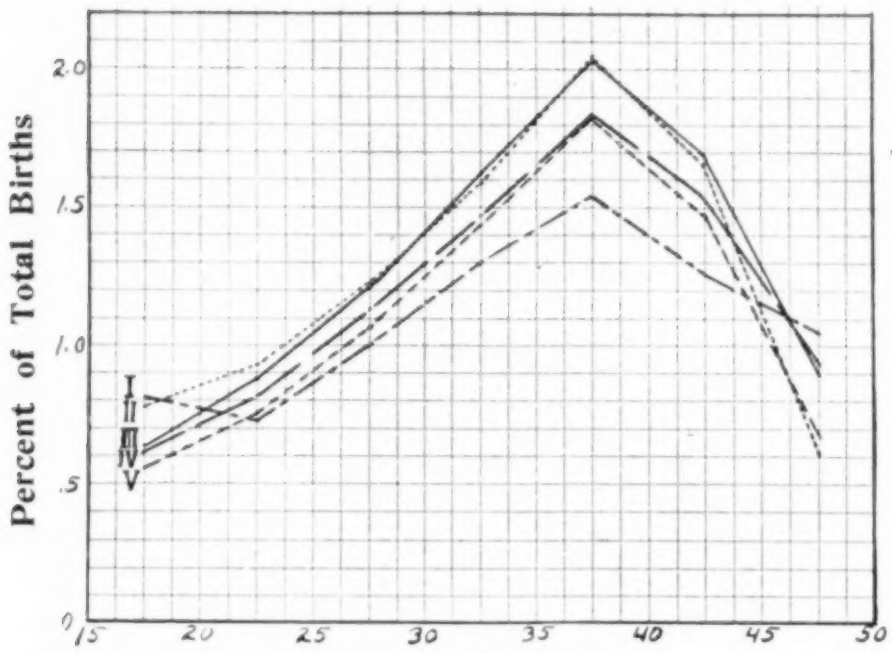


Figure 6

THE DISTRIBUTION OF TWIN FREQUENCIES BY AGES OF MOTHERS

I. France 1902-1906
II. Denmark 1896-1910
III. Finland 1878-1916
IV. U. S. Birth Registration Area 1923-1924
V. France 1907-1910

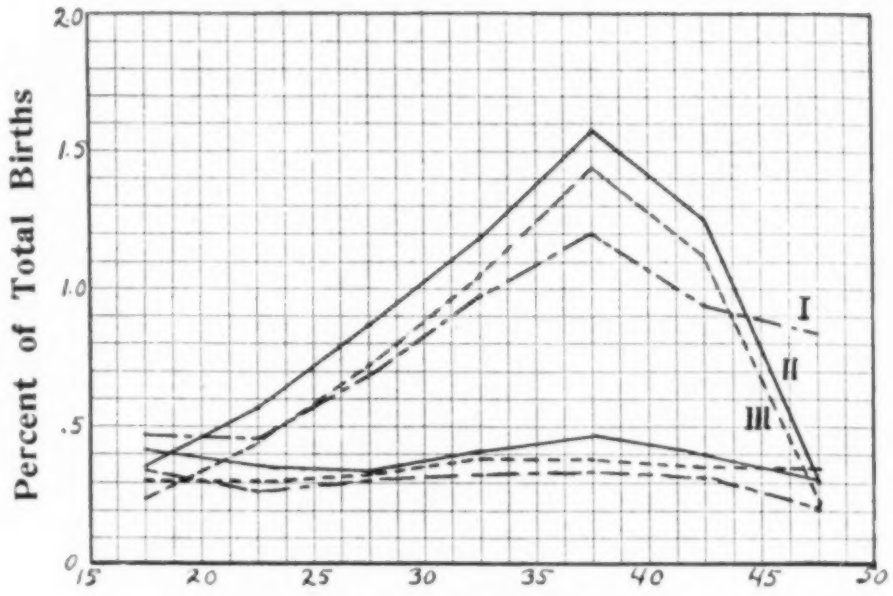


Figure 7

THE FREQUENCIES OF MONOZYGOTIC AND DIZYGOTIC TWIN BIRTHS BY AGES OF MOTHERS

I. Dizygotic Twin Births, France 1902-1906
II. Dizygotic Twin Births, Finland 1878-1916
III. Dizygotic Twin Births, France 1907-1910

The corresponding lower graphs represent the frequencies of monozygotic twin births.

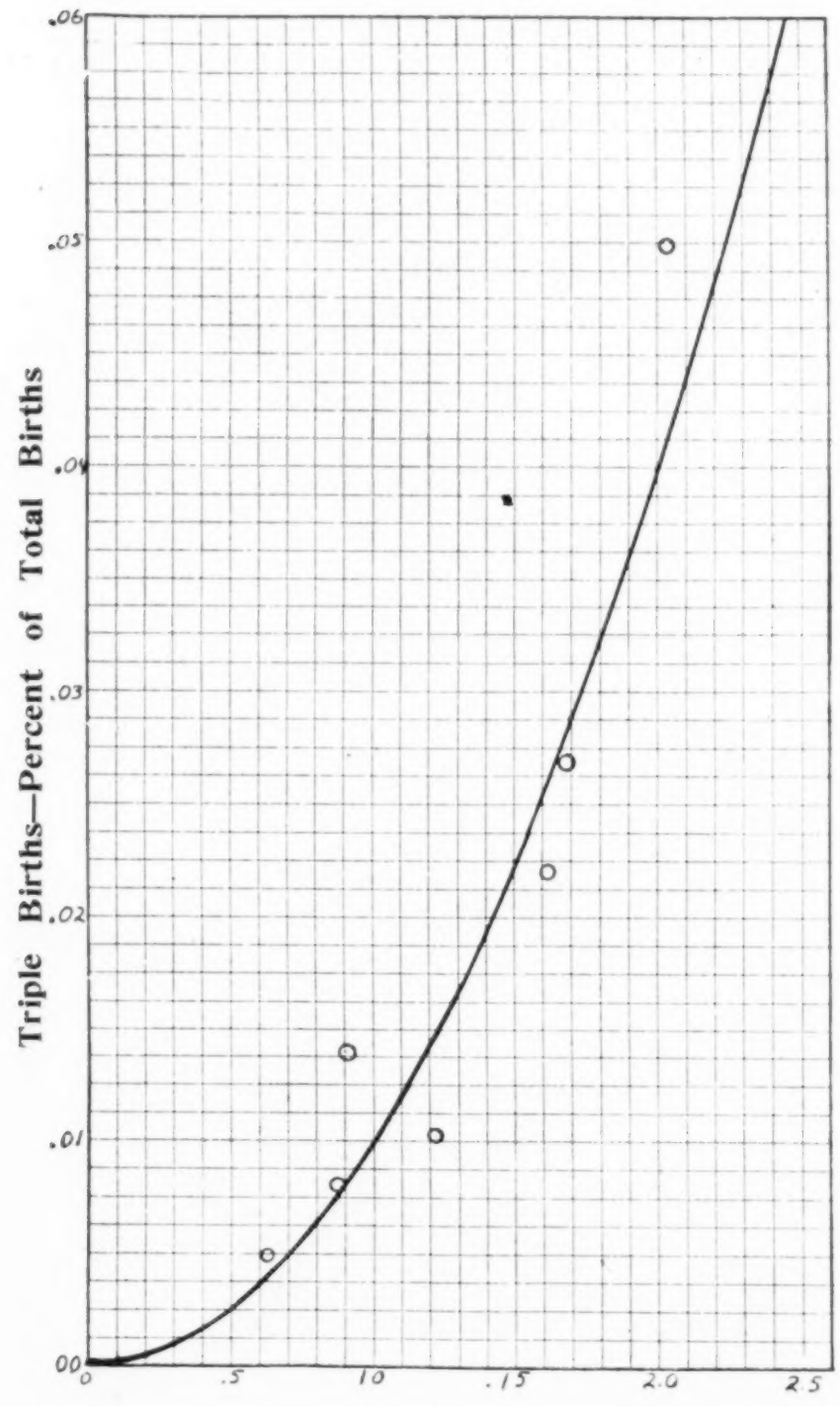
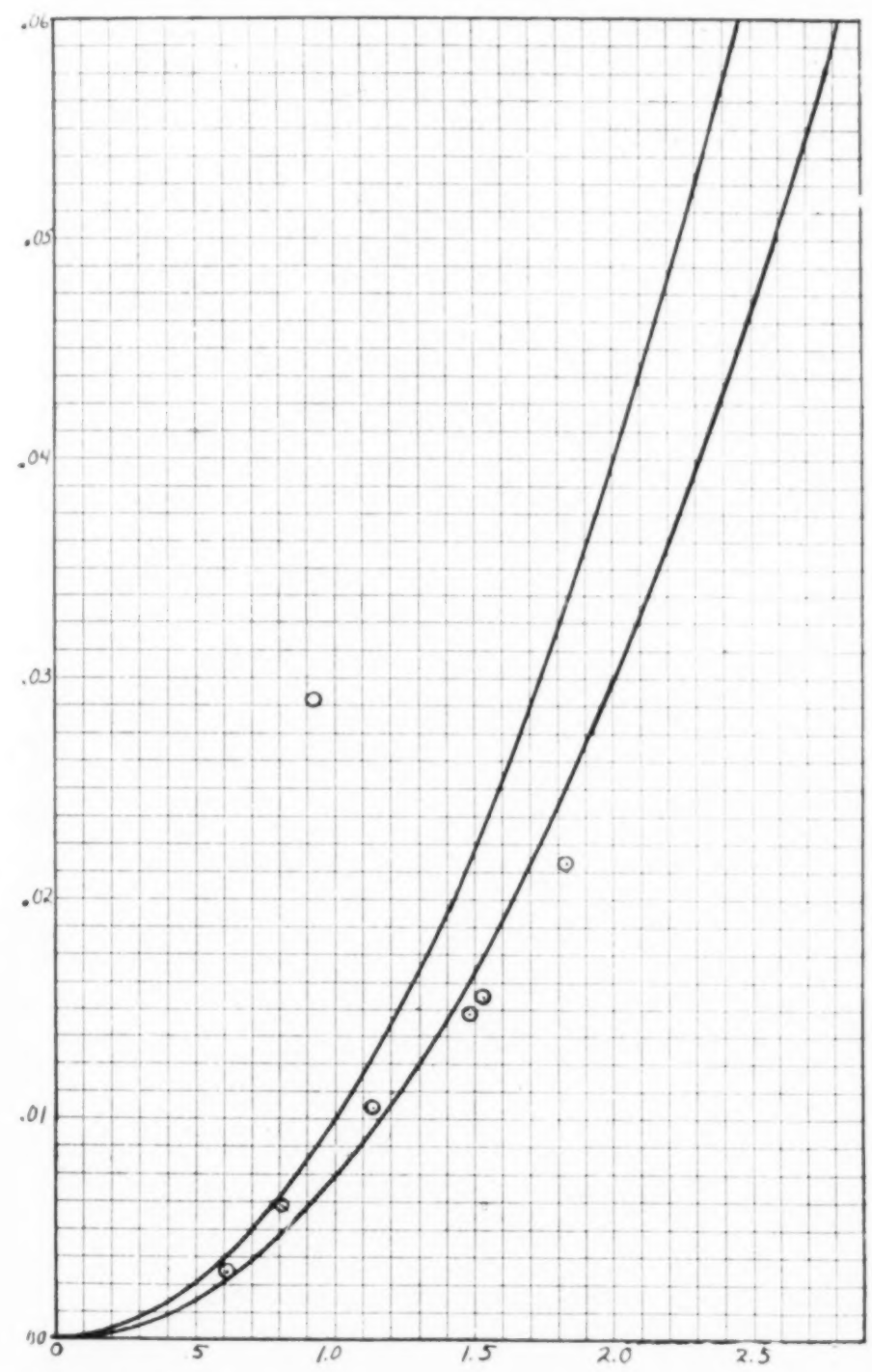


Figure 8



Twin Births—Percent of Total Births

Figure 9

RELATION BETWEEN TWIN AND TRIPLE BIRTHS

(Figure 8) In Finland 1878-1916 (Dahlberg); (Figure 9) U. S. Birth Registration Area, 1923-1923.

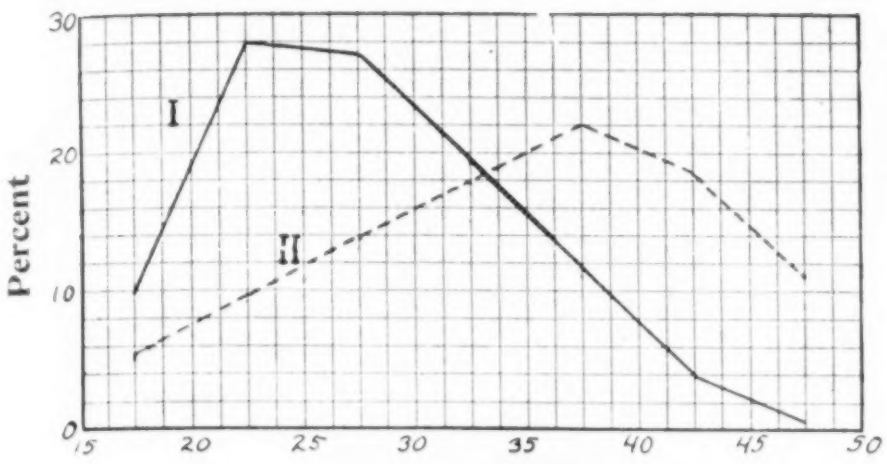


Figure 10

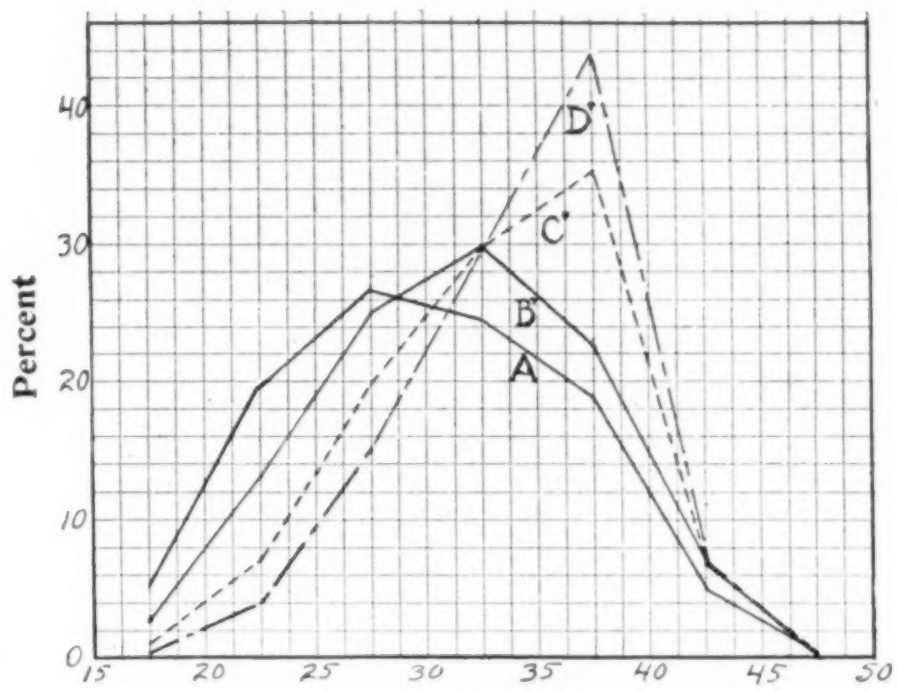


Figure 11

CALCULATED DISTRIBUTION OF PLURAL BIRTHS

I. Total births.

II. Twin frequencies.

The peak of twin births occurs about fifteen years later than the peak of the total births curve.

A, twin—observed; *B*, triplets (calculated); *C*, quadruplets (calculated); *D*, quintuplets (calculated).

By this method it has been shown that while the frequency of monozygotic twin births (expressed in terms of per cent of births by mothers of any given age group) is practically constant for any age of mother, the frequency of dizygotic twin births similarly expressed is distinctly a function of the age of the mother, rising gradually to a maximum at 35-40, and then falling. Table II and Figure 7 show this relationship.

Mirabeau was apparently the first to call attention to the relationship between triple births and age of mothers. His table is included in Table V. Dahlberg, in 1926, published a table of the relationship of frequency of triple births and age of mother (Table III). The table suggests that the frequency of triple births may vary as the square of the frequency of twin births. Plotting twin birth frequencies against triple birth frequencies, we obtain Figure 8. The heavy line is the curve (Frequency of triple births) $=$ K (Frequency of twin births)^2 when K equals 1. The agreement is striking. The point most in error is based on only six cases of triple births.

Here we may say, then, that the frequency of triple births at any age of mothers not only varies with, but *is equal to*, the square of the frequency of twin births at that age.

I have been able to secure data for only one other such table—this for the U. S. Birth Registration area, 1923-1924. This was given in Table IV and Figure 9. The upper curve of the graph is plotted from the equation frequency of triple births $= K$ (Frequency of twin births)^2 when $K = 1$. It will be observed that only one point is widely in error, and this is based on only four cases. A better agreement is obtained, however, by the lower curve, in which $K = 3/4$.

What does this $3/4$ mean? It seems unlikely that different laws govern the occurrence of triple pregnancies in the United States and in Finland. It must be borne in mind that the plotted points on the United States Birth Registration Area graph are based on a total of only 395 cases, and that it is not impossible (though unlikely) that their disagreement from the curve where $K = 1$ is a matter of chance error. I strongly suspect (though I cannot prove) that the true expression for the occurrence of *multiple pregnancies* is (Frequency

of triple pregnancies), = K (frequency of twin pregnancies)^2, where K = 1, and that and diminution of the factor K in the equation for *plural births* is due to a high differential mortality of triplets *in utero*, compared with that of twins. This would give us the relationship that the frequency of triple births would *vary as* the square of the frequency of twin births, without necesarily being *equal* to it—the type of relationship represented by the lower curve of Figure 9. It is not unreasonable that such a differential mortality exists, considering the more unfavorable conditions under which the development of triplets must occur. Why there should be a different differential mortality of triplets *in utero* in this country than Finland, I do not know, but it would not seem particularly unlikely that it should be so. The fact that the curve is in agreement for Finland does not prove that there is not a differential *in utero* mortality of triplets there, for if the *in utero survival frequency* of triplets equaled the square of *in utero survival frequency* of twins, the shape of the curve would not be changed, although the differential mortality might be great.

If we accept the rule that the frequency of triple pregnancies for any age of mothers is the square of the frequency of twin pregnancies for that age, then it becomes apparent that the total number of triplet pregnancies for all ages of mothers would be, not the product of the total number of births and the square of the frequency of twin pregnancies for all ages of mothers, the type of relationship expressed by Hellin's Law, but would be the sum of the products of the square of twin pregnancy frequency for each age of mother and the number of births by mothers of that age. Put more simply, Hellin's law states

$$T = P^2 N$$

where T is the total number of triplet births, P is the frequency of twin births for all ages of mothers, and N is the total number of births.

The suggested rule, on the other hand, would imply that

$$T = \Sigma P^2 N$$

where T is the total number of triple *pregnancies*, P is a variable, frequency of twin *pregnancies*, Σ a function of the age of the mother, and N another variable, the number of pregnancies by mothers of the same age.

Calculating the expected number of triplets in Finland 1878-1916 by this formula, we obtain results shown below.*

Here the deviation is 2 per cent by this rule and 5.3 per cent by Hellin's law.

In the smaller number of cases from the United States the agreement is less good†.

Here the error is 34.7 per cent, as against 24.1 per cent by Hellin's law, but the number of cases is smaller, so that chance errors are slightly increased and, as has been pointed out, a higher frequency of miscarriages and stillbirths and absorption of fetuses among triplets may be entirely adequate to account for this discrepancy.

There is every reason to suppose that the same type of relationship holds true for quadruple and quintuple births, with P raised to the third and fourth power, respectively, here. Adequate data for a complete checking are not available on these, but I have been able to collect the ages of mothers in a number of these cases, an item which may be

*Triplets in Finland, 1878-1916.

Age of mother	15–20	20–25	25–30	30–35	35–40	40–45	45–50	Total
Calculated	3	47	125	203	242	90	4	714
Observed	4	49	86	172	299	84	6	700
Calculated by Hellin's law								663

†Triplets in United States.

Age of mother	15–20	20–25	25–30	30–35	35–40	40–45	45–50	Total
Calculated	13	66	127	150	142	23	1	532
Observed	11	61	102	103	92	22	4	395
Calculated by Hellin's law								490

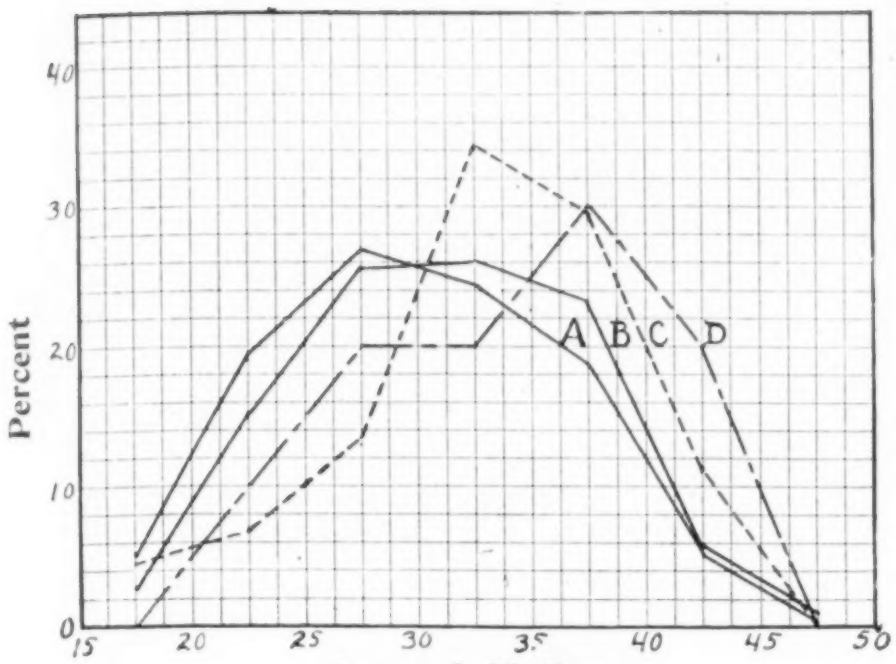


Figure 12

A—Twins. B—Triplets (395 cases). C—Quadruplets (44 cases). D—Quintuplets (20 cases).

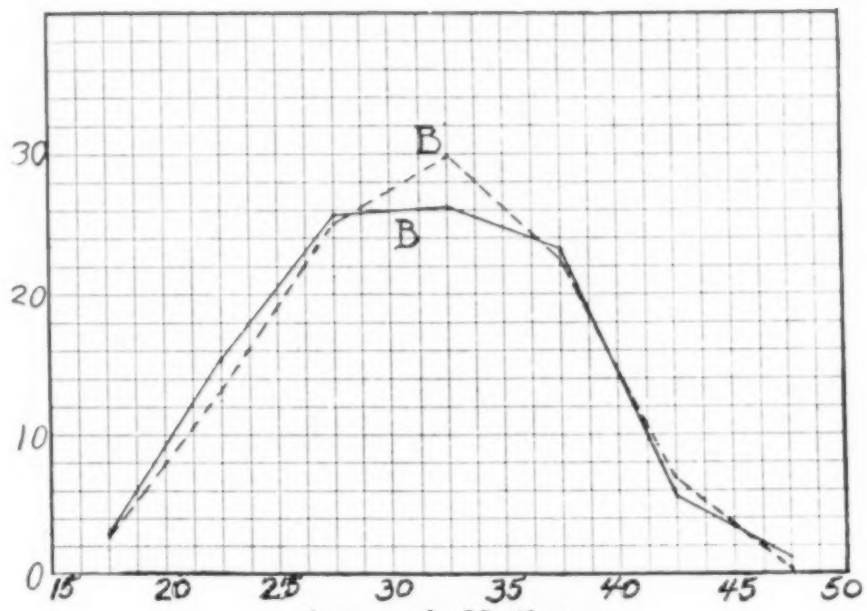


Figure 13 (Triplets)

B'—Calculated; B—Observed (395 cases).

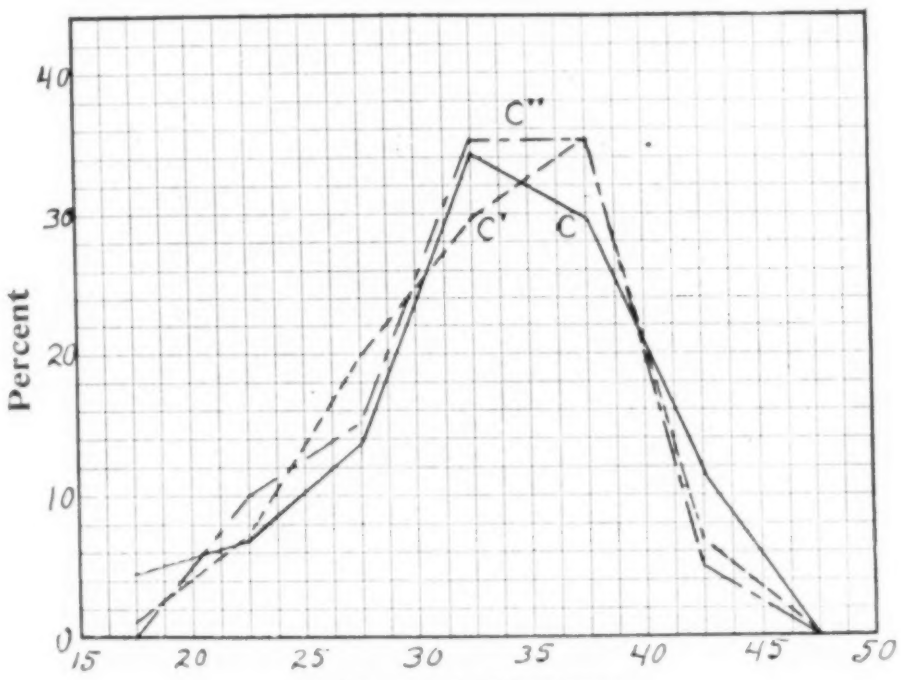


Figure 14 (Quadruplets)

C'—Calculated; C—Observed (44 cases); C''—Observed (Hauser).

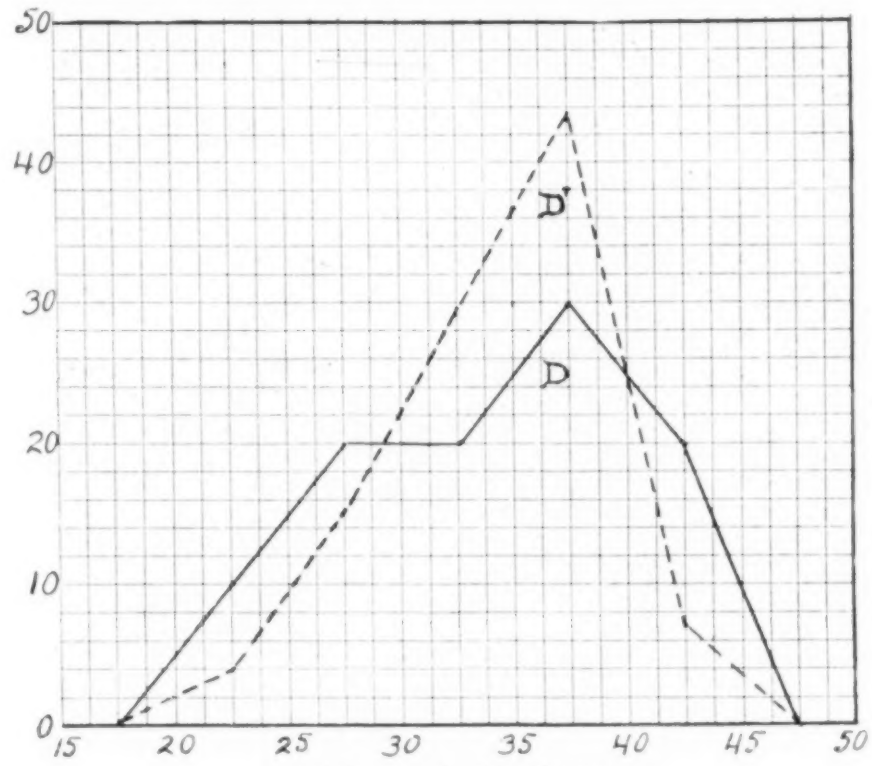


Figure 15 (Quintuplets)

D'—Calculated; D—Observed (20 cases).

OBSERVED DISTRIBUTION OF PLURAL BIRTHS BY MOTHER'S AGES

of some value. It should be noted that the numerical occurrence of twins at various ages of mothers is the product of two factors, the frequency of twins at that age and the total number of births by mothers of that age. Figure 10 shows that the frequency of twin births is greatest at a period of life distinctly past the maximum fecundity, hence the peak of total number of twin births occurs at a later age of mothers than the peak of the total number of single births. If the equation I have presented holds, the peaks of total number of triplet, quadruplet and quintuplet births should be progressively shifted toward the period of greatest frequency of twin births, by the progressive weighting of this factor as it is squared, cubed and raised to the fourth power, respectively, as is indicated by Figure 11, based on the United States Birth Registration Area Reports for 1923-1924. That this is true is indicated by Table V and Figures 12, 13, 14, and 15.

In the cases of quadruplets and quintuplets, the number of cases is so small, and any error incurred in choosing twin frequencies in the United States as being typical for the populations from which these cases are drawn would be so magnified as the factor is cubed and raised to the fourth power that the

agreement is certainly as good as can be expected.

Another point of interest, in passing, is shown by Table VI. The fact that twin frequency increases not only grossly with an increase in the number of pregnancies, an effect which might be due solely to the age factor, but also that *for a constant age of mother* the greater the number of previous pregnancies, the greater the frequency of twin births.*

It would be interesting to know whether or not the same type of relationship would hold here—that for a given age of mother *and a given number of previous pregnancies,* the frequency of triplets would vary as the square of the frequency of twins—and so on. If so, the formula for the total number of triplets would be $T = \Sigma P^2 N$ where P is a function, not only of the age of mother but also of the number of the pregnancy. This might constitute a third approximation. I know of no data available for checking this hypothesis.

Why should the relationship $T = P^2 N$ hold? Logically, assuming that the same probability factors govern all multiple pregnancies, we might expect a relationship such as follows, where ○○ represents dizygotic twins ⊖ monozygotic twins and *a* and *b* their respective frequencies:

		Frequencies	
○○	Dizygotic twins	a	$(a+b)$
⊖	Monozygotic twins	b	
○○○	Trizogotic triplets	a^2	$(a+b)^2$
⊖○	Dizygotic triplets	$2ab$	
⊗	Monozygotic triplets	b^2	
○○○○	Quadrazygotic quadruplets	a^3	$(a+b)^3$
⊖○○	Trizygotic quadruplets	$3a^2b$	
⊖⊖	Dizygotic quadruplets	ab^2	
⊗○	Dizygotic quadruplets	$2ab^2$	
⊕	Monozygotic quadruplets	b^3	

There are insufficient data, so far as I have been able to discover, to test these individual frequencies directly, but we have a method available by an extension of Weinberg's rule. By this, the likelihood of trizygotic triplets being opposite-sexed is $.750 - .3a^2$, that of dizygotic triplets being opposite-sexed is $.5 - 2a^2$, and that of monozygotic triplets being opposite-sexed is, of course, 0. Disregarding the factors containing *a* as negligible, it is an easy matter to calculate the expected frequencies of same-sexed and opposite-sexed triplets. Having done so and checked my results against the actual ratios in about 15,000 cases of triple births, I find that they do not at all agree. The number of cases is far too large to consider chance errors the cause. The same type of disagreement is obtained by checking the predicted number of triplets of each type against the ratios of the few cases of triplets that have been classified as monozygotic, dizygotic and trizygotic, but here the chance errors might be large.

What is the meaning of this? The fact that the total frequency of triplets may be predicted with fair accuracy by the relation:

$$(a^2 + 2ab + b^2 = (a + b)^2$$

(*triplet frequency*) (*twin frequency*)^2

and that the frequencies of the various types of triplets cannot be predicted by

*Two alternative explanations particularly suggest themselves—one, that repeated pregnancies *per se* influence the reproductive system of women in some way to increase the likelihood of twinning, and the other that a hyper-fecundity naturally accompanies the tendency to twinning and is responsible for the mothers at a given age who bear twins, having had more previous pregnancies than mothers of the same age who have not borne twins.

this method strongly suggest that *the development of monozygotic and dizygotic twins are not separate and distinct phenomena, but are in some manner fundamentally inter-related — are controlled by the same factors and are perhaps to be considered as two phases of the same phenomenon,* and that any satisfactory theory of twinning or of the inheritance of the tendency to twinning must take this into account.*

Conclusions

1. The frequency of triplet births at different ages of mothers varies as the square of the frequency of twin births at those ages.

2. It seems likely that the frequency of triple pregnancies at any age of mother is equal to the square of the frequencies of twin pregnancies at that age, and that any deviation from this rule in plural births is due to a differential mortality of twins and triplets in utero.

3. The frequencies of quadruplet and quintuplet births at different ages of mothers seem to vary as the cube and fourth power, respectively, of the frequencies of twin births at those ages.

4. If (2) be accepted, then the total number of triplet frequencies would be predicted by the formula

$$T = \Sigma P^2 n$$

where P is a variable, the frequency of twin pregnancies and Σ is a function of the age of mother, and *n* another variable is the number of pregnancies by mothers of that age.

5. For a constant age of mother, twin frequency increases with increase in the number of previous pregnancies. This suggests that in the above equation, P is not only a function of the age of mother, but also a function of the number of previous pregnancies.

6. The fact that the prediction of the total number of triplets is reasonably accurate, while the prediction of the various types (monozygotic, dizygotic, trizygotic) does not agree with the observed data strongly suggests that the development of monozygotic and dizygotic twins are not separate and distinct phenomena, but that in some manner they are governed by the same factors.

TABLE I—Twin Distribution by Ages of Mothers in Different Countries (Dahlberg)

Countries	Age of Mothers 15—20	20—25	25—30	30—35	35—40	40—45	45—50	Total[‡]
Finland 1878—1916								
Total Births[†]	81,491	611,681	846,645	777,624	598,321	314,910	42,836	3,276,568
Twin Births	519	5,386	10,243	12,566	12,166	5,327	386	46,631
% (of Total Births)	0.64	0.88	1.21	1.62	2.03	1.69	0.89	1.42
Denmark 1896—1910								
Total Births	37,235	235,283	317,618	257,248	175,592	75,404	6,724	1,114,249
Twin Births	282	2,177	3,873	4,095	3,579	1,245	41	15,300
% (of Total Births)	0.76	0.93	1.22	1.59	2.04	1.65	.61	1.37
France 1902—1906								
Total Births	227,047[*]	1,095,504	1,243,172	856,168	527,539	210,994	29,025	4,206,979
Twin Births	1,828	7,959	12,464	11,136	8,130	2,650	306	45,351
% (of Total Births	0.81	0.73	1.00	1.30	1.54	1.26	1.05	1.16
France 1907—1910								
Total Births	175,131	868,208	925,078	658,465	385,721	143,982	13,533	3,218,547
Twin Births	977	6,638	9,917	9,500	7,031	2,127	94	36,653
% (of Total Births)	0.56	0.76	1.07	1.44	1.82	1.48	0.69	1.14
	A Similar Tabulation from the U. S. Birth Registration Area Reports 1923—1924							
U. S. Birth Reg. Area 1923—1924								
Total Births	359,173[*]	1,010,030	976,504	693,796	425,840	141,082	13,768[**]	2,682,975
Twin Births	2,188	8,185	11,116	10,193	7,785	2,156	128[**]	42,456
% (of Total Births)	0.61	0.81	1.14	1.47	1.83	1.53	.93	1.153

TABLE II—The Distribution of Monozygotic and Dizygotic Twin Births by the Age of the Mothers and in Per Cent of Total Births According to Weinberg's Differential Method (Dahlberg)

	Age of Mother Under 20	20–25	25–30	30–35	35–40	40–45	45 & up	Total
Triple Births	11	61	102	103	92	22	4	395
Twin Births								
% of Total Births	0.609	0.811	1.139	1.468	1.829	1.528	.928	1.153
Triple Births in Thousandths % of Total Births	3.1	6.0	1.05	1.48	2.16	1.56	2.91	1.07

TABLE III—Triple Births in Finland 1878–1916 Grouped by Ages of Mothers and Related to Births and Twin Births (Dahlberg)

	Age of Mother 15–20	20–25	25–30	30–35	35–40	40–45	45–50	Total
Births (number of mothers)	81,495	611,730	848,731	777,796	598,620	314,994	42,844	3,274,210
Twin Births	519	5,386	10,243	12,566	12,166	5,327	386	46,593
Triple Births	4	49	86	172	299	84	6	700
Triple Births in Thousandths % of Births	4.9	8.0	10.2	22.1	49.9	26.7	14.0	21.4
Triple Births in % of Twin Births	0.77	0.91	0.84	1.37	2.46	1.58	1.55	1.50
Twin Births in % of Total Births	.627	.881	1.209	1.616	2.033	1.691	.901	1.423

*In this connection it may be interesting to mention that unpublished studies in another department of the University of Chicago from an entirely different approach, viz., the resemblance of dizygotic twins, suggests a closer interrelation of monozygotic and dizygotic twinning than has commonly been accepted.

TABLE IV—Twin Births and Triple Birth Frequencies in the U. S. Birth Registration Area, 1923-1924, after Age of Mothers

	Age of Mother							Total
	Under 20	20–25	25–30	30–35	35–40	40–45	45 & over	cases
Twins (U. S. Birth Reg. Area 1923--1924)	5.2	19.6	26.7	24.4	16.7	5.1	.3	41,751
Triplets (U. S. Birth Reg. Area 1923--1924	2.8	15.4	25.7	26.1	22.3	6.7	1.0	295
Triplets (Mirabeau)	1.8	12.1	21.4	32.1	21.4	10.7	0.0	
Quadruplets (Brattstroem 19 cases, Hafeli 12 cases, Author 13 cases)	4.5	6.8	13.6	34.1	29.6	11.4	0.0	44
Quadruplets (Houser)	0.0	10.0	15.0	35.0	35.0	5.0	0.0	20
Quintiplets (Du Blecourt 17 Author 3)	0.0	10.0	20.0	20.0	30.0	20.0	0.0	20

TABLE V—Distribution of Plural Birth (Expressed in % of Group) by Ages of Mothers

	Age of Mothers							
Countries	15–20	20–25	25–30	30–35	35–40	40–45	45–50	Total
Denmark 1896--1910 Opposite-Sexed Twin Pairs	67	675	1,374	1,519	1,379	472	10	5,498
% Monozygotic	0.42	0.36	0.35	0.41	0.47	0.40	0.31	0.38
% Dizygotic	0.36	0.57	0.87	1.18	1.57	1.25	0.30	0.99
France 1902--1906 Opposite-Sexed Twin Pairs	539	2,494	4,298	4,153	3,166	991	122	16,069
% Monozygotic	0.34	0.27	0.31	0.30	0.34	0.32	0.21	0.38
% Dizygotic	0.47	0.46	0.69	0.97	1.20	0.94	0.84	0.76
France 1907--1910 Opposite-Sexed Twin Pairs	217	1,964	3,396	3,504	2,774	804	22	12,618
% Monozygotic	0.31	0.31	0.34	0.38	0.38	0.36	0.35	0.34
% Dizygotic	0.25	0.45	0.73	1.06	1.44	1.18	0.34	0.80

TABLE VI—The Frequency of Plural Births, Expressed in Per Cent, of Various Ages of Mothers and by Various Ordinal Numbers of Birth.

	Number of Birth										
Age of Mother	Total	First	Second	Third	Fourth	Fifth	Sixth	Seventh	Eighth	Ninth	Tenth
Under 20	.6	.5	.6	1.3	.8	1.4	0	0	0	0	0
20—24	.8	.7	.8	1.1	1.0	1.4	1.5	1.9	2.6	1.0	0
25—29	1.1	1.0	1.0	1.2	1.3	1.2	1.5	1.4	3.1	2.0	2.0
30—34	1.5	1.4	1.2	1.4	1.6	1.6	1.6	1.7	1.6	2.3	2.8
35—39	1.9	1.2	1.4	1.6	1.6	1.8	2.0	2.0	2.2	2.3	2.4
40—44	1.6	.9	1.1	1.3	1.5	1.6	1.7	1.7	1.8	1.4	1.8
45—49 and older	1.2	.6	0	.8	.3	1.3	1.3	1.3	2.4	1.8	1.0
Unknown	.6	1.0	.9	.3	0	.3	.4	.9	.8	0	.6
All ages	1.2	.9	1.0	1.2	1.3	1.5	1.7	1.8	2.0	2.1	2.2

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A Selective Turnover among British Farmers

A LINE of investigation that should receive more attention in the study of farm problems in the United States is opened in an article in *The Sociological Review* for April, 1926, on "The Social Origin of Farmers in Wales": by A. W. Ashby, (Hon.) M. A., and J. Morgan Jones, B. A., Agricultural Economics Department, University College of Wales, Aberystwyth.

Previous writers have reported from several districts in England that about two-thirds of the farmers were farmers' sons, while about one-third had been farm laborers or were recruited from other occupations. Even such a turnover in each generation in a relatively very stable population is very significant from the standpoint of eugenics. The results of the investigation in Wales are summarized as follows:

. . . . Taking all the groups together, about 75 per cent of the present farmers are descended from farmers.* About 11 per cent of them are sons of farm workers, nearly 7½ per cent are sons of manual workers not engaged in agriculture; and nearly 6 per cent are descended from artisans. The most surprising features are that so few of the "incomers" are descended from persons in trades and professions, and that such a large proportion are descended from manual workers not engaged in agriculture and from artisans, for these two groups together exceed the numbers in the group who are descended from farm workers. Again, it is clear that the persons who enter the occupation of farming, not being sons of farmers, tend to enter on the smaller farms; and that the proportion of the present farmers who are sons of farmers is highest in the farms with the higher rentals, though the proportion is not highest in the group with the highest rentals.

The last statement, however, tends to obscure the very important fact that even on the farms with the higher and highest rentals there are many farmers who have been more distantly derived from other classes, and that there is a constant flow of "new blood" from one level to another. But the most important fact that there is a loss of the "farming families" to the industry is not directly shown by the figures. This loss is considerable and probably amounts to about 20 per cent of the total as each generation of farmers passes. It may amount to the 25 per cent represented by the "incomers" but does not appear likely to be quite so much at the present time, because of some tendency to increase the number of small farms and thus the total number, making some new opportunities for the new men. . . . Yet if the whole class of farmers is as steady in numbers as the *Census* indicates, then nearly a quarter of the farmers in every generation appear to be derived from non-farming families.

This is an exceedingly important fact. It affects considerations on rural education, general and technical; it affects considerations of need of credit facilities; and it affects all considerations of the economic and social principles which should determine the size of the holding or of the unit of business in farming. If a quarter of the farmers are recruited from families in which they do not obtain the social and intellectual inheritance of farming knowledge and experience, and if the majority of these do not inherit and have to save capital, provision must be made to assist them if personal capacities and national material resources are to be used to the best advantage.

There is also another aspect of the facts contained in this analysis which is not at first obvious. Farming obtains "new blood" and new, and mostly saved, capital from the new-comers. But it loses equally in personnel and in capital through the loss of the families which are displaced. "Displaced" is perhaps not an adequate term. There is some evidence of real displacement in the records. There are indications not only of an "upward drive" of the new-comers, but also of a "downward drift" of the farming families. To some extent there is displacement through real and effective competition. There is also loss of efficient personnel of farming families, possessing capital, through sons and daughters passing out to other trades and to the professions, thus making openings for new-comers. The whole process is one of a gradual rise of new-comers, a gradual depression of the weaker families of the farming class and of the passing out of efficient capable personnel often at a stage of comparative affluence. (Pp. 135-137.)

*This follows closely the general estimates made for England.

Origins of Domesticated Animals

NATUERLICHE RASSENGESCHICHTE DER HAUSSAEUGETIERE, *by* MAX HILZHEIMER. Pp. 235 with 124 illus., price $3. Berlin, Walter de Gruyter & Co., 1926.

There are three main ways in which the fascinating problem of the ancestry of domesticated animals can be studied: (1) by genetic experiment, (2) by archæological and historical research, and (3) by the methods of comparative zoology. The first is costly and has been little done; the second is uncertain because there are large parts of the earth in which no excavations have been made. Dr. Hilzheimer, therefore, depends largely upon the third method, although making use of the others when possible. He devotes special attention to the great diversity in shape of skull in a given species, and concludes that it is due to the arrest of development of individual parts at various ages. The book is written in a simple way, primarily for breeders rather than for zoologists; but the inclusion of references to the original authorities would have been advantageous. It should appeal to a wide circle of readers. *P. P.*

A COOL WEATHER PALM

Figure 16

The familiar household palms usually called Kentias are adapted to outdoor conditions along the coast of California, where the weather is always cool. Our household palms are the seedlings of two genera of palms which are natives of Lord Howe Island, in the Southern Pacific Ocean, east of Australia. This palm is *Denea forsteriana* growing as a lawn tree at San Diego, California.

KENTIA PALMS IN CALIFORNIA

South Pacific Island Palms Adapted to Coast Conditions

O. F. Cook

U. S. Department of Agriculture

PALMS symbolize the Tropics, as plants of hot climates or greenhouses. That any palms are adapted to a cold climate and unable to endure heat, may seem anomalous, but a few species are restricted to cool regions. Many of the palms of the tropics are not found in the hot lowlands, but only in the cooler mountain districts, though such limitations to high altitudes have been ascribed to a need of continuous moisture, rather than to a requirement of low temperatures. Some palms resist frost, but do not grow normally without warm weather. The hardy palmettoes of the Southeastern states do not thrive on the Pacific coast, probably for lack of sufficient heat. Another kind of hardiness is required in order to grow at low temperatures.

Two species of palms usually known as Kentias are now being planted in the open air in southern California, and are showing by their behavior that they are well adapted to conditions near the coast, in range of the cool breezes from the Pacific. Favorable conditions are indicated by the thrifty growth of the plants and by regular production of flowers and fruits on some of the older individuals.

The Kentias are the palms that in the Eastern states are seen most frequently in household cultivation and in conservatories. The species are familiar to florists and gardeners, one as *Kentia belmoreana*, with curved leaves and erect pinnae, the other *Kentia forsteriana*, with straight leaves and flat, drooping pinnae. The differences of habit and general appearance will be appreciated by reference to the photographs. (See Figures 19, 21, and 23).

The coast belt of California has a special climate, protected from frost by the proximity of the ocean, but with the weather so cool in summer that most of the tropical palms are unable to grow. As with many other plants, the limiting factor is not the cold of winter, but the lack of heat in summer. The demand for plants that can thrive near the sea is becoming more acute with the rapid increase of population in the coast districts. To find that we can grow and see about us one of the most beautiful palms in the world should seem as interesting and important as to discover gold mines or oil wells. The beauty of the palms is a satisfaction and enrichment of life.

The narrow coast strip of California has a human interest and value out of all proportion to the area of land or the special products than can be furnished by the coast districts to other parts of the country. Visitors from the East go to California in the winter, but the coast districts are enjoyed especially in the summer. Thousands of people go "out to the coast" every year from the hot interior valleys and find in the cool climate and entirely different surroundings a wonderful feeling of relief from the heat and glare of the desert. The physical pleasure of the change of temperature is intensified by the interest and enjoyment of the contrasting features of the coast country. Hence it is to the advantage of the coast communities to make themselves as attractive as possible, for visitors and new settlers from the East. Many new communities are being established and it may be expected that within a few decades the entire coast belt from the Mexican border to San

Francisco will be occupied and inhabited. Millions of people will live in the future in the coast belt where the Kentia palms grow.

Many large fruiting specimens of *Kentia forsteriana* are to be seen in San Diego, in parks and private grounds. Some of the finest palms are in open lawns or drive-ways where they have stood for 20 years or more and have attained a height of 25 to 30 feet. Also there are excellent specimens at Santa Barbara and probably at other places along the coast. This species is more abundant and apparently thrives better than *Kentia belmoreana,* but the latter is also represented by thrifty individuals that have begun to fruit, both at San Diego and Santa Barbara. The two species are strikingly contrasted in appearance, and notable variations occur, so that plants with special grace and beauty may be highly prized. The selection and breeding of special forms undoubtedly will be undertaken as soon as the individuals that show distinctive characters begin to produce seed.

No doubt the Kentias will be planted in much larger numbers as soon as their special adaptations for coast conditions are recognized. Probably they can be grown at many places along the coast that are too cool for other palms to thrive. If properly placed and in good condition they are one of the most attractive features of the coast country. The firm-textured, deep green foliage has distinction of color and form. The use of Kentias should not be restricted to lawns and parking. Group plantings should be very successful, especially in locations somewhat sheltered from the south and east, either among buildings or in ravines or gullies. In places back from the coast, as at Los Angeles and Pasadena, it is the more necessary to avoid the open southern exposures for the Kentias, as well as for Loroma and Archontophoenix. The palms have a finer appearance and are easier to keep in good condition through the summer if planted on northern slopes, or in partially shaded situations.

While most of the Kentias that are growing outdoors in California are still young, the adult characters are shown in many well-grown individuals, especially of *Kentia forsteriana.* A study of the adult fruiting palms in California shows several specialized characters that may be considered as adaptations to cool climates, and also several structural differences between the two commercial species that require the recognition of separate genera, though doubtless they will continue for a long time to be called Kentias.*

Natives of Lord Howe Island

The origins of the Kentias are not in doubt. There are no difficult historical questions to debate as with the coconut palm or date palm. The natural distribution of these palms is limited to one point in the Earth's surface, a small island named Lord Howe, in the South Pacific, between Australia and New Zealand, about 500 miles from Sydney, in the direction of Norfolk Island. Lord Howe Island was discovered in 1788, and is famous only for its Kentia palms. There were no native inhabitants, but settlers came from Australia and a few from Norfolk Island, which in turn had people from Pitcairn Island, descendants of the mutineers of the "Bounty," the ship that was sent by the British Government to introduce the breadfruit into the West Indies. The small resident population is engaged entirely in collecting and shipping the seeds of the Kentias to Europe, by way of Sydney, to supply the horticultural trade. An account of the palm seed industry appeared in *Chambers' Journal*† in 1923, with several interesting features:

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*A New Genus of Palms Based on *Kentia Forsteriana. Journal of the Washington Academy of Sciences* 16:392. Aug. 19, 1926.

†Lord Howe Island, by Thomas J. McMahon, in *Chambers' Journal,* published April 2, 1923. Pp. 255, 256.

Lord Howe Island, otherwise known as "Opal" Island, lies in the South Pacific Ocean, out from Australia in a line north-east of Sydney a distance of some 450 miles. It is a beautiful dependency of New South Wales, and, despite the distance apart, is included in the electorate of Sydney. The island has a coastline of but twenty miles, and is less than 3,500 acres in extent. It has a rare fertility, and at present has big prospects of a trade with Australia in fruit and vegetables. The island is visited by a trading-steamer from Sydney every two months.

Lord Howe is especially noted for its kentia palm seed industry. This industry is unique in the commercial world. The small and dainty palm to be seen in pots on banquet-tables, as an embellishment to wedding ceremonies, in hotel vestibules, and in shop windows, giving a freshness and brightness to all around—that is the kentia palm. Go to any capital, large city, or town of any civilized country, and the Lord Howe kentia palm is in evidence. In warm and moderate climates it luxuriates in the open; in cold zones it is preserved in hot-houses; and there is only one tiny speck of land in the Seven Seas where the seeds of this much-sought plant fertilize. That is in the rich, loamy soils of the hills and valleys of this beautiful island of Lord Howe, in the South Pacific.

About 130 people live on Lord Howe. All the men and boys, ninety or so in number, have something to do in connection with the seed-collecting. The young men do the climbing of the palms for the seed. They run up trees monkey-fashion, and collect the bunches of seed with much dexterity. The older men attend to the sorting, cleaning, bagging, and all other preparations for export. For most months of the year the industry is carried on with little interruption. Over 5,000 bushels of seeds are exported annually, the market price varying from £2 to £2, 10s. a bushel.

There are four kinds of kentia palms—the thatch, the curly, the umbrella, and the mountain, the last a dwarf specimen. The first two species grow on the low lands of the island and to a moderate height. The umbrella palm is found inland from 1,000 feet upwards, while the mountain palm flourishes only above 2,000 feet. For each sort of palm there is needed a special climate. In other words, as there are four kinds of palms, there are four varieties of climate on Lord Howe. This is most manifest as one ascends from the shore towards the summits of the mountains.

There are two mountains on the island—Mount Gower, 2,800 feet, and Mount Lidgbird, 2,500 feet. Right to the top of these run palms, giving the whole landscape a delightful and unusual charm. These mountains, seen far out to sea, are striking landmarks, with their sublime atmospheric colour effects—sometimes purple, sometimes blue, sometimes pink. Viewed from the sea, Mount Gower is a great straight-up wall of rock of 1,000 feet in height—a magnificent sight, like a vast mass of polished opal.

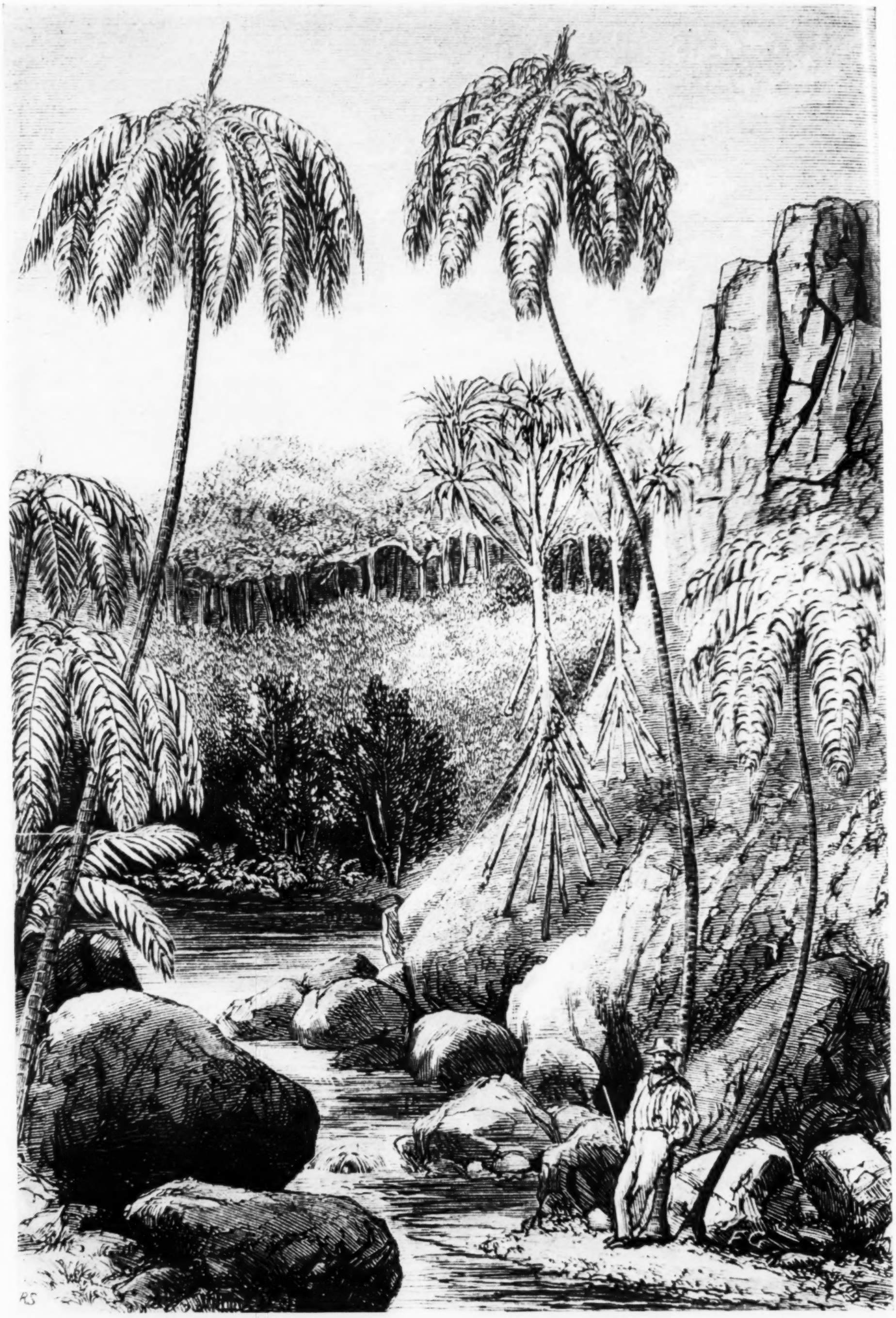
Lord Howe is a very attractive island all the year round, having a cool, even, and healthful temperature, making it an ideal resort for visitors. Many may be inclined to think the inhabitants native, owing to the dark colour of their skin; but there is not one "black" person on the island. Most of the settlers originally came from New South Wales, and some few from Norfolk Island, a little over 600 miles to the north. The people are a contented, happy folk, leading the simple life, undisturbed by the rush and worries of life, independent of the high cost of living, having no rates and taxes to pay, no house and land rents—and no picture shows. They are famous for their hospitality, and a visitor comes away charmed with them. They are not troubled with politics; they have a vote, but apparently are not much concerned whether they use it or not.

During the war the kentia palm seed industry suffered a slump, not because there was no demand for seed, but for the reason that all the young, able-bodied men of the island joined up with the Australian forces. They were a fine, strapping, sturdy body of men. All of them who came back have medals to show or honours to their credit. Since their return the palm-seed industry has resumed its old activity, and a recent shipment of seeds amounted to many hundreds of bushels.

Every little house on the island is a home of many comforts; each has its plot of garden, its vegetables, and fruit-patches. There is a well-grassed common, and here graze a fine herd of cattle and some splendid horses. Pigs and poultry are reared in abundance.

The death-rate is the lowest in the world. Some of the folks have reached ages well over three score and ten, and are as active and energetic as if only half the age. There is no magistrate, no policeman, no doctor on the island. As one of the old settlers declared, "No one breaks the law, and no one is ever sick; there is no need for a doctor, for when people die they die a natural death."

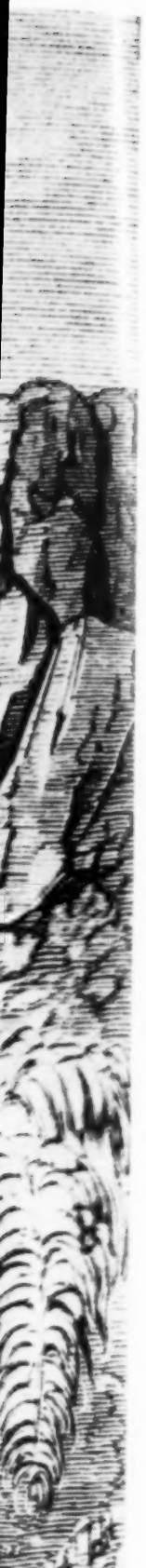
The settlers live together in one little settlement, in which there are a school and two churches, one Church of England, and the other Seventh Day Adventist. So neighbourly are the good folk that it might be said they are one big family, all ambitious for the progress of the island and the success of the kentia palm industry.



SKETCH OF LORD HOWE FLORA

Figure 17

The first illustration of Kentia palms, published with Mueller's descriptions. At the left, *Kentia forsteriana* at the right *Kentia belmoreana*, with the native screw pine (Pandanus) on stilt-like roots; a native fig-tree with many trunks in the background.



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Economics of the Palm Island

The system of conducting the palm seed industry is explained by another visitor to Lord Howe Island, who features the islanders as "A Population of Stockholders." In other parts of the world the exploitation of natural resources usually has been destructive to the native populations, while the valuable plants or animals are reduced or exterminated. Why the Kentia palm island has not been devastated and the palms exterminated by goats or seed-pirates, is explained as follows:*

> Under Commonwealth government the island practically became a reserve. Original settlers and their descendants were allowed to remain, but they can neither own nor lease land. Theirs is a permissive occupancy. To counterbalance this obvious drawback the Government pays a standard wage of four shillings a bushel for gathering seed, and also presents every islander, male and female, with shares in the Kentia palm industry—twenty-five at birth and fifty at the age of twenty-one. These bring in three pounds ten shillings a month, so it is possible for each islander, from his work and his dividends, to make approximately three pounds per week. With this they seem entirely satisfied. . . . "We have a comfortable living, a home and our wives and children; what more do we want?"
>
> Outsiders are now, alas! rigorously barred from settling on Lord Howe and entering into the Kentia palm industry. Only one course is open—to marry an islander, and at once become the possessor of a comfortable home and a wife, with a substantial dowry. Many a wandering sailorman has done this in the past, and no doubt many more will do so in the future, for, curiously enough, although five pounds has been offered for the ceremony, an islander has never yet married an islander.

Congratulations may be tempered by the reflection that the palms might not have been preserved if an active demand for the seeds had not arisen. It is only an accident if the value of a plant happens to be recognized at the time of its discovery. As on many other islands, cattle, goats or rabbits might have been turned loose and allowed to exterminate the native plants. The lack of interest in nature makes this possible, even in sight of the coast of southern California. Unique and interesting island floras are being destroyed, including many species of plants that do not exist on the mainland of California, or anywhere else in the world.

No doubt the time will come, possibly within a few years, when it will be recognized as a supervandalism to destroy the special forms of life that exist only in small numbers, on islands or in limited areas, like the Torrey pine or the Monterey cypress in California. One of the most beautiful fan-palms in California, *Erythea edulis*, is limited in nature to Guadeloupe Island off lower California. Thousands of the Guadeloupe palms are now growing on the mainland, and producing seed in abundance.

Discovery of the Lord Howe Palms

That one small island of the southern ocean should have four kinds of palms, very different from each other and found nowhere else in the world, is one of the remarkable facts of geographic distribution. Palms of related genera are found in Australia and widely scattered in the islands, one genus is in New Zealand, one in the Chatham, Kermadic and Norfolk Islands while other genera are in Polynesia, New Caledonia and New Guinea. But Lord Howe Island, with its four palms and many other endemic plants, stands out from the thousands of other islands as an actual remnant of an ancient land mass which is believed to have existed in former geologic ages. An arm of the Antarctic continent is supposed to have extended to the northward, to include New Zealand, New Caledonia, and the Fiji Islands.

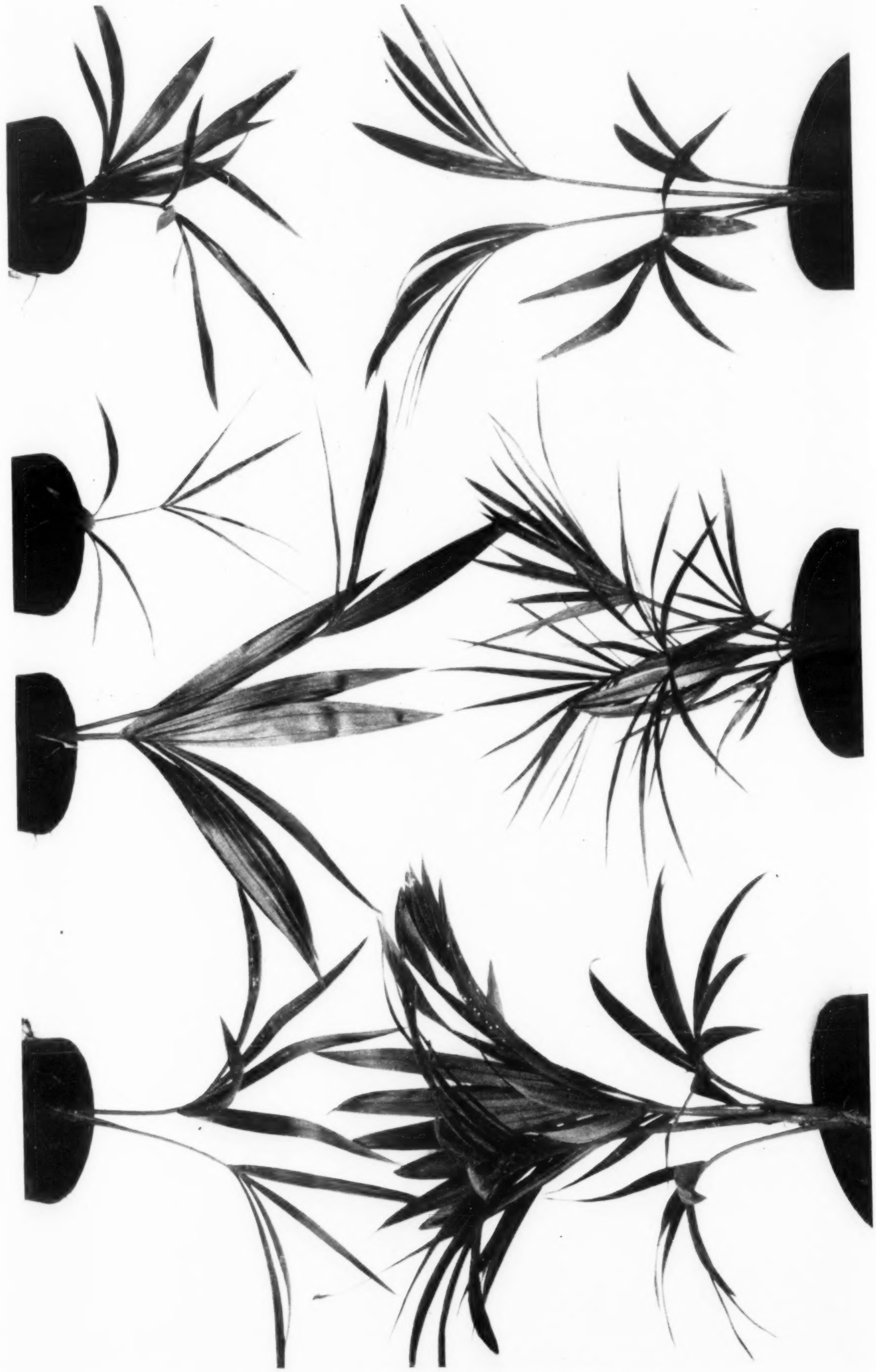
As surviving members of an ancient Antarctic flora narrowly rescued from extinction, as though by a mere accident that one small island remained above the waters of the Pacific, the Lord Howe palms have a special scientific

*From "In Search of Adventure" by Ralph Stock, in *The Wide World Magazine*, No. 210, Vol. 35, October, 1915, pp. 556, 557.

SEEDLINGS OF HOWEA AND DENEA

Figure 18

On the left *Howea belmoreana* with the first leaves usually divided into four separate segments, and the following leaves with gradually more numerous segments. On the right *Denea forsteriana* with simple two-lobed leaves, usually four of the simple leaves before a compound leaf appears, like the first leaf of the Howea seedlings. The second plant in the front row of Denea shows a compound leaf with five segments, like a leaf of Howea. Photograph at National City, California, at the nursery of Mr. Gustav Teufel.



On the left *Howea belmoreana* with the first leaves usually divided into four separate segments, and the following leaves with gradually more numerous segments. On the right *Denea forsteriana* with simple two-lobed leaves, usually four of the simple leaves before a compound leaf appears, like the first leaf of the Howea seedlings. The second plant in the front row of Denea shows a compound leaf with five segments, like a leaf of Howea. Photograph at National City, California, at the nursery of Mr. Gustav Teufel.

Figure 18

VARIATIONS IN PALM SEEDLINGS

Figure 19

Six seedlings of *Howea belmoreana* showing the first leaves usually with four or more segments, and one plant of *Denea forsteriana*, at the upper right hand corner, with the first leaves simple. Note the differences in the size and shape of the leaves of the Howea seedlings, germinated under the same conditions. Selected from Mr. Teufel's plants to show the range of variation in seedling characters.

YOUNG PALM AND FRUIT OF DENEA

Figure 20

A young plant growing in a lawn in San Diego, California, showing the habit of the palm in the earlier stages of growth, with gracefully drooping flat pinnae.

Section of inflorescence, showing mature fruits, with an example of branching of the inflorescence above the insertion of the second spathe, so that the two branches were included in the same spathe (natural size).

interest, in addition to their value as ornamentals. The world's palm flora would have been notably poorer if this remnant of the ancient world had been covered by the waves.

In such remnants of a lost Antarctic flora, special characters and adaptations may be expected and may indicate the conditions to which the palms were subjected in former periods of geologic history. Also a special botanical interest will attach to the relationships of the Lord Howe palms with those of other regions, which as yet have not been determined.

From this standpoint it will be seen that the discovery of the Lord Howe Flora was a biological event of much importance. The existence of dense forests of palms was reported by MacGillivray and Milne who visited the island in 1853, but without detailed information. The true discovery of the palms occurred in 1869 when a three-day's visit to the island was made by C. Moore, director of the Sydney Botanic Gardens. Moore's sketch of the vegetation of Lord Howe Island was published in the *Gardeners' Chronicle* for September 11, 1869. Four kinds of palms were distinguished, with interesting data regarding their habits and conditions of growth:

I have lately had an opportunity of visiting Lord Howe's Island, which lies off our coast (Sydney) some 300 miles. It is small in extent and scarcely known to any but navigators. A few observations relative to the botany of the place, may therefore be interesting to your readers. The island is situated in lat. 31° 36′ S., and long. 159° 5′ E. It is somewhat semicircular in form, about 4½ miles in length, and 1¼ miles at its widest part. On its southern extremity there are two mountains, over 2,500 feet high; from the base of these to the northern end, where the ground again rises to an elevation of about 1,200 feet, the intervening space is of a low undulating character. The whole of the island is densely covered with a vegetation mainly consisting of trees, shrubs, and palms, there being no barren spots upon it, excepting the precipitous cliffs of the mountains and coast. From this description of its size and breadth it will be apparent that the greater part of the island is subject to the effects of the sea breeze; yet, on the southern and most exposed side, palms and exogenous trees grow down to high-water mark, and, except in being dwarfed, seem to be otherwise entirely unaffected by exposure.

After passing the first belt of trees, a species of fig (Ficus) abounds, and occupies much of the low-lying grounds. In general appearance it greatly resembles *F. macrophylla* of our eastern coast. It differs, however, from that plant by its smaller fruit and foliage, by the under-part of the leaves being more ferruginous, and by its great tendency to produce adventitious roots from its branches, which, after reaching the ground, become stem-like, so that in many instances it is difficult to determine the original trunk. In this respect it is the most remarkable species of Ficus I have met with in this part of the world. The largest tree of the kind which I noticed was, as nearly as possible, about 100 yards from the extremity of the branches on one side to that on the other, and had very numerous root-stems. It was a glorious sight, and one long to be remembered. In two or three instances these trees were found forming, as it were, a circle round an open space. This, it was plain, was caused by the original tree dying off entirely in the center, and its branches in consequence becoming so many separate individuals. It is called Banyan by the settlers, after its great prototype of Indian notoriety. No other species of Ficus was observed.

Among these figs, and in every situation upon the island, whether high or low, to the extent of my investigations, two similar, but very distinct species of Areca Palm abound, one of which is called by the settlers the Cabbage, or Thatching Palm, from the fact of its fronds being the only material used for thatching upon the island. This is managed by the base of the foot-stalk of the frond doubling just below the pinnae, at which point it is worked on a batten, secured in the roof for this purpose. The stalks are brought rather close together on the inside, forming a row of ribs, which has a somewhat neat appearance and the feathery spray, or pinnae, on the outside, become an outer covering, of from 7 to 8 inches in thickness, rendering the interior impervious to wet, and cool and comfortable to the inhabitants; it will last from eight to ten years. The other palm, equally abundant, and intermixed with the one just noticed, is not used for any special purpose. It is of a more slender habit, having shorter and more arching fronds, with the pinnae rising from the rachis instead of falling as in the former, giving it a rather peculiar appearance, from which it is called by the settlers the Curly Palm. Both of these produce very large quantities of fruit, the drupe being of an ovate form, about 1 inch in length, and both have simple spadices (the latter having the longest), produced from

ing flat pinnae.

Section of inflorescence, showing
the two branches were included in

Howea Belmoreana

Denea Forsteriana

KENTIA PALMS IN CALIFORNIA

Figure 21

The commercial Kentia palms belong to different genera, easily distinguished by the habits of growth and the characters of the inflorescence; *Howea belmoreana*, with the leaves strongly curved and crowded, erect, folded pinnae. *Denea forsteriana*, with straight leaves and open-spaced, flat pinnae. The inflorescences of Howea are simple, while those of Denea are branched. Photograph of Howea from a palm at Coronado, California, grown by Mrs. M. O. Terry; of Denea from La Jolla, a few miles north of San Diego.

among and below the lower fronds. The seeds of both kinds are eaten with the greatest avidity, and are, indeed, the principal support of the large bodies of settlers' pigs, running in most parts of the island.

At an elevation of about 1,500 feet, nearly the limit of the preceding species, another and very beautiful palm occurs, called the Umbrella Palm by the settlers. It has large pinnate fronds, with a branching spadix, bearing a large plum-like fruit, which is of a reddish colour when ripe. This tree is comparatively rare, and is strictly confined to the sides of the two high mountains, on the tops of which another and smaller species of palm than any of the preceding kinds is said to grow in very great abundance, the fruit yielding the chief food of the wild pigs running about in that part. I speak of this palm only from hearsay, as neither I, nor any of the party who visited the island with me, succeeded in reaching either of the mountain's tops. The settlers, who frequently go there to hunt wild pigs, describe it as comparatively low in stature, and bearing a profusion of roundish-shaped fruit. This island, therefore, though very small in extent, produces four distinct species of palms, none of which, I think, are described.

Scarcity of Kentia Seeds

Recently it is reported that the supply of Kentia seeds from Lord Howe Island is falling off rapidly on account of a "plague of rats," so that commercial horticulturists have no assurance of seed in the future. How to destroy the rats without introducing some other pest that may be as bad or worse may be a difficult problem. Different measures no doubt are being tried, one of which is reported in *Our Dumb Animals*, for June, 1926. A shipment of California barn owls is being furnished to the Australian government, to be sent to Lord Howe Island, to serve as rat-catchers. If the owls from California will save the Lord Howe palms, a very interesting example of biological reciprocity will be afforded.

Presumably, some way of controlling the rats will be found, so that the usual quantities of seed can be exported within a few years. Otherwise the commercial growers of Kentias in Europe and America may encounter serious losses. The investment in greenhouses and equipment for raising the Kentia seedlings and supplying the trade amounts to several millions of dollars. Some of the large horticultural establishments are reported to have used 75 bushels of Kentia seed per year to keep their conservatories stocked.

If the scarcity of seed continues it will appear very fortunate that the Kentias have begun to fruit in California. Only small quantities of seed are as yet obtainable, since most of the palms are still young, but even a few thousand seeds will allow the number of palms to be gradually increased. It is to be hoped that the local seed will be used for outdoor planting in California, so that more seed will be available in the future though it probably would take ten or fifteen years to bring a palm to the fruiting stage, even with the most favorable conditions. At least there is an assurance that the species need not become extinct, even if it proved impossible to get seed from Lord Howe Island in the future.

Two Commercial Kentias

The "curly palm" and the "thatch palm" are the species that have commercial importance and are growing and fruiting in southern California. The commercial species have been known to the trade as *Kentia belmoreana* and *Kentia forsteriana*, though not closely related to the original species of Kentia, which came from New Guinea. Recent botanical writers have referred both of the commercial Kentias to the genus Howeia, or Howea, as it usually is written, but there are several structural differences that call for recognition as separate genera.

The names of the two species have often been reversed on account of a mistake by the original describer, Baron von Mueller. The name "curly palm" was associated witht *Kentia belmoreana* in the original description, and "thatch palm" with *Kentia forsteriana*, but in a later account purporting to relate to *belmoreana* characters of *forsteriana* were given, including the compound in-

Figure 21

The commercial Kentia palms belong to different genera, easily distinguished by the habits of growth and the characters of the inflorescence; *Howea belmoreana*, with the leaves strongly curved and crowded, erect, folded pinnae. *Denea forsteriana*, with straight leaves and open-spaced, flat pinnae. The inflorescences of Howea are simple, while those of Denea are branched. Photograph of Howea from a palm at Coronado, California, grown by Mrs. M. O. Terry; of Denea from La Jolla, a few miles north of San Diego.

florescence and the oblong seeds. In reality the seeds of *belmoreana* are shorter and broader than those of *forsteriana*.*

*The generic name Howea belongs with the species that has simple inflorescences and curled leaves, originally described as *Kentia belmoreana*, while the other species, *Kentia forsteriana*, with compound inflorescences and straight leaves, is placed in a new genus called Denea. Even the young plants of Denea are easily distinguished from Howea by their flat, horizontal, or drooping pinae, with the midrib prominent underneath as well as above. The curved rachis and the erect pinnae give *Howea belmoreana* a striking and characteristic appearance, contrasting notably with *Denea fosteriana* (See Figures 16 and 21).

The leaf-structure of Howea is more specialized, with the pinnae not opening flat but remaining strongly arched or channeled underneath, and held in erect or ascending positions. The pinnae are set so close along the rachis that there would not be room for open, flat pinnae like those of Denea. The crowding of the pinnae in Howea may account for the bending of the rachis. Another specialization of Howea is that the midribs of the pinnae are more prominent on the upper side than in Denea, but not prominent underneath.

In well-grown specimens the trunk of Denea is thicker than in Howea, and a greater height is attained, from 60 to 80 feet, or even 100 feet in exceptional cases, as reported from Lord Howe Island. More rapid growth is made possible in Denea because the joints of the trunk are longer, attaining 12 cm. or more, while the internodes of Howea are very short, usually less than 3 cm. The leaf-scars of Denea are oblique, while those of Howea are transverse. The epidermis of the long internodes of Denea remains alive and green for many years, while on the short internodes of Howea the epidermis is less persistent and most of the surface is covered with leaf-scars, so that the trunk appears gray.

The branches of the inflorescence of Denea are inserted in a row across the end of the short, flattened basal joint, and each of the branches behaves like an independent inflorescence, with its own cylindrical spathe. No other palm inflorescence is known that branches at the base, below the second spathe, so that there is only one united basal joint. (Figure 25)

It is difficult to understand how the Denea inflorescence could be derived from the usual form of branched inflorescence, with the axis and its branches included in a single complete spathe. The characters of the Denea inflorescence seem more consistent with the idea of derivation from a palm with simple inflorescences, like Howea, as though a series of simple inflorescences had grown together at the base, while remaining distinct above the basal joint.

Tendencies to reduce and simplify the inflorescences are apparent in many groups of palms, and simple inflorescences are found in several genera that are not related to Howea or to each other, as Bactris, Geonoma, Chamaedorea, Wettinia, and Phytelephas. Two or more inflorescences are formed in the axil of the same leaf in Chamaedorea, Wettinia and Catostigma, but there is no complete parallel to the inflorescence of Denea.

In Denea, as in Howea, the flowers and fruits are inserted in deep cavities of a stout, cylindrical axis, but in Denea the lower margin of the cavity is formed by a thickened bract and is notched on each side. The male flowers of Denea have two or three times as many stamens as those of Howea. Beccari reports 30 to 40 stamens with short filaments in *belmoreana*, and 80 to 100 stamens with long filaments in *forsteriana*. Beccari, O., 1913. *Webbia*, 4:168.

The fruits of Denea are fusiform, longer and narrower than the fruits of Howea, and set closer together along the axis. Also the seed is narrower in Denea, and the bony endocarp thinner, with the hilum and the operculum much smaller. The endocarp in both genera is extremely hard and flinty, with the same specialized columnar structure as in Pseudophoenix, Manicaria and Phytelephas.

With the separation of Denea from Howea the four endemic palms of Lord Howe Island, all described originally as species of Kentia, are recognized as distinct monotypic genera, as follows:

(1) *Howea belmoreana*, the "Curly Palm"; (2) *Denea forsteriana*, the "Thatch Palm"; (3) *Hedyscepe canterburyana*, the "Umbrella Palm"; (4) *Lepidorhachis mooreana*, the 'Mountain Palm." The last species has been associated with palms from the Samoan Islands, under the name *Clinostigma mooreanum*. The genus Clinostigma was established by Wendland in 1862 for *Clinostigma samoense*. The name Lepidorhachis was first suggested by Wendland and Drude, in 1875 for a section of Clinostigma, later admitted to represent a distinct genus. (See Drude, in Engler and Prantl, Die Naturlichen Pflanzenfamilien II, 3; 69, 1889.)

The Mountain Palm appears to be related also to the genus that occurs in the South Pacific islands to the east of Lord Howe, including New Zealand and in three outlying groups, the Norfolk, Kermadec and Chatham islands, probably a different species in each group. The Chatham Island palm has the distinction of growing farthest from the equator,

Slow-Ripening Fruits and Other Special Adaptive Characters

That the seeds of Kentias are collected through most of the year is explained by the remarkable persistence of the fruits. Instead of ripening at a definite season and then falling off, which is usual among palms, the Kentia fruits have remarkable non-ripening adaptations. Not only the seeds, but the seedcoats and the inflorescenses retain their vitality and remain in place on the palms for long periods, or until forcibly detached.

The habit of retaining the fruit through several seasons is illustrated in Figure 25 from a palm growing at Coronado, photographed in November, 1923. The palm had been fruiting for 7 or 8 years, but had most of the inflorescences still in place.* This peculiar habit of holding the inflorescences from year to year might be described as a natural storage of the seeds. The effect of such a specialization would be to protect the species against the danger of bad seasons when the conditions were such that seeds failed to germinate or the seedlings could not survive.

The inflorescences are remarkable in having the fruiting axis very compact and greatly thickened, with the flowers and fruits inserted in deep pits. The tissues and texture of the axis, of the floral envelopes, and of the pericarp or covering of the fruit, are very firm and tough, heavily charged with chlorophyll. The retention of the fully developed fruits is made possible because the entire inflorescence, axis, floral envelopes and pericarps retain their vitality as vegetative tissues, remaining green and fresh indefinitely. No such persistent vitality of the inflorescences after the ripening of the fruits has been noted in other palms.

For the retention and preservation of the seeds of Denea and Howea in place on the palm for long periods a specialization of the fruits is required, as well as of the inflorescences. The integuments of the fruit are of closely compacted fibers embedded in remarkably hard and firm tissue, green near the surface and yellowish green underneath. The epidermis is not specially thickened but is tough and resistant, and coated with wax.

The structure of the fruit undoubtedly is an important factor in the keeping quality of the seed. As long as the integument remains alive the seed is protected and possibly does not begin to germinate until the integument dies. Probably the chief danger is from the drying and splitting of the integuments, so that the endosperm is exposed and the embryo is soon collapsed and shriveled.

Many palms have the seeds enclosed in hard, woody or bony shells, which may be covered with a thick mass of fibers, and the fibers usually are embedded in a fleshy, sweet or oily pulp. The coconut palm even has a supply of water stored in the seed which is so well packed in moist fibers that the

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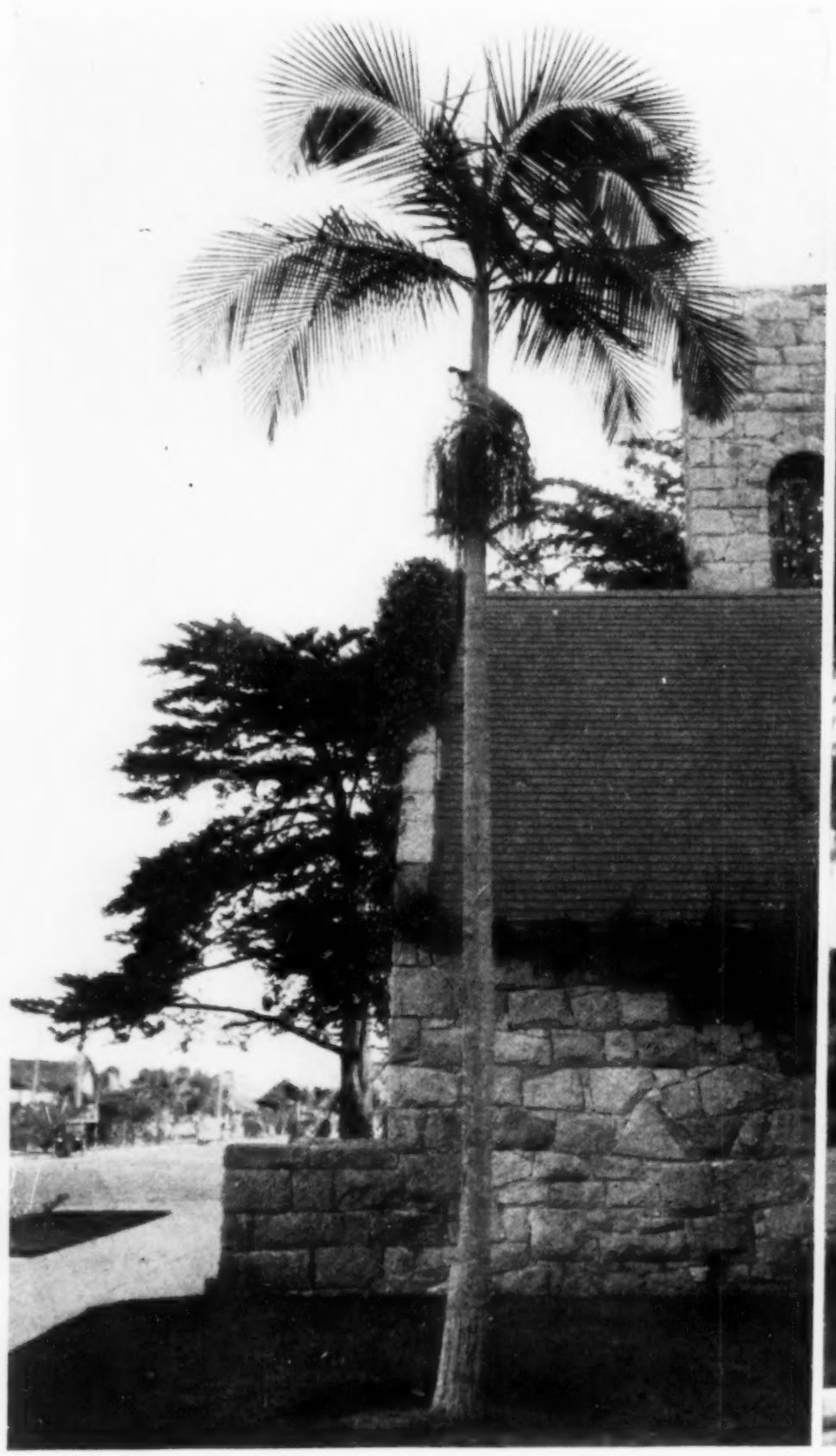
in a latitude of 44 degrees, corresponding to Maine or Oregon. The New Zealand species has been introduced into California, and has fruited in the open air at San Diego and Santa Barbara. It is discovered too late for publication elsewhere that the name Rhopalostylis, which has been applied to the New Zealand palm and the related species of the other islands was preoccupied by a genus of Euphorbiaceae, and the new name Eora is suggested, with *Eora sapida* (Solander), the New Zealand palm, as the type species. The Norfolk Island species is *Eora baueri* (Wendland and Drude), and the Kermandec species *Eora cheesemani* (Beccari). For the Chatham Island palm the name *Eora ultima* would be suitable. Von Mueller says that it has a tomentose midrib, but corresponds in other respects to the description of *sapida*. For descriptions and references to the species, see Beccari, Trans. and Proc. New Zealand Inst., 49:47, 1917.

*This palm was grown by Miss L. B. Baird, Adele Ave., Coronado. It was raised in Massachusetts from a small plant, and was 4 or 5 feet high when brought to Coronado and set in the open, in 1905. The leaves were killed in the freeze of 1913, but in other seasons have not been injured.



PALMS CONFUSED WITH KENTIAS

Figure 22

At the left Loroma, at the right Archontophoenix, both natives of Australia, and often confused. In the middle the New Zealand palm, *Eora sapida*. This specimen of Loroma is at Coronado, California, the Archontophoenix at Bradenton, Florida, and the Eora at the Huntington Estate, San Marino, California.

seedling can grow for several weeks before forming any contacts with the soil. Long-lived exocarp tissues in Denea and Howea may be considered as another adaptation for retaining moisture and keeping the seed from drying out until the seedling is able to draw moisture from the soil.

Slow Germination of Seed

The seeds of most of the palms are short-lived, with embryos of delicate texture that shrivel and die if once exposed to drying. Some of the palms that grow in desert regions have seeds that survive long periods of drying, but the Kentias are not "hard-seeded" like desert palms. To keep the seeds from drying out they are packed for shipment in the spongy rotten wood of the large banyan-like fig-tree of Lord Howe Island, *Ficus columnaris*.

The firm texture and persistent vitality of the integuments no doubt are chiefly responsible for the fact that the seeds endure several months of storage and shipment before reaching their final destinations in the seed-beds of the commercial horticulturists of Europe and America. Most of the soft-seeded palms would not survive such long periods of shipment before germination, with any method of packing.

As might be expected, many of the Kentia seeds succumb to the vicissitudes of the long journey, so that germinations of more than 50 per cent are not expected. Two principal shipments were received each year, one in February or March, and another in September or October. The seeds that came in the fall were supposed to give the best results.

Even after the seeds are planted, germination may be very slow. Seeds were still germinating in a seed-bed four years old at National City, California, in a greenhouse not heated artificially.

Supposed Hybrid Kentias

Two individual palms that were supposed to be hybrids between *forsteriana* and *belmoreana*, are reported by Oliver although he recognizes that they may be variants rather than hybrids. The characters were noted as follows:

Specimen 1.—Characters of *H. Forsteriana*: Leaves with drooping pinnae, spikes in clusters of three or four, stem stout, fruit long. Characters of *H Belmoreana*: Spikes long, 1.6 m.

Specimen 2.—Characters of *H. Forsteriana*: Leaves with horizontal or slightly drooping pinnae, spikes in clusters of three or four. Characters of *H. Belmoreana*: Spikes long (much longer than those of *H. Forsteriana* in same locality), pinnae in central leaves with upward tendency, stem slender, fruit robust.

In both cases it appears that the longer inflorescences were the more conspicuous feature that called attention to the plants. Possibly the smaller number of branches might explain their greater development, since the growth of such branches is indeterminate. Variations in the number of branches would be expected and would hardly be taken as evidence of hybridity.

The "upward tendency" noted for the pinnae in the "central leaves" of the second specimen may mean nothing, since the pinnae of all palms stand upright at first. The retention of an upright position by the pinnae of the mature leaves is the distinctive feature of *belmoreana*, rather than the position of the pinnae in the young leaves.

The "robust fruit" of the second specimen appears to be a more definite variation than the slender trunk. A palm with a slender trunk would be more likely to have an inflorescence with few branches. Trunks are more slender where conditions are less favorable, and fruits may be larger if only a few are set.

Variations in Seedlings

Some of the contrasting characters of Howea and Denea are shown by the leaves of the seedlings. The seedlings of Denea have simple, bilobed leaves, as in many other palms, while in Howea seedlings all of the leaves

Figure 22

At the left Loroma, at the right Archontophoenix, both natives of Australia, and often confused. In the middle the New Zealand palm, *Rhopalostylis sapida*. This specimen of Loroma is at Coronado, California, the Archontophoenix at Bradenton, Florida, and the Howea at the Huntington Estate, San Marino, California.

DENEA WITH OTHER PALMS

Figure 23

A group of palms on the Gillepsie Estate, Montecito, California, showing similarity and contrasts of foliage characters. Denea at the right, a young Loroma near the center, and a small Eora somewhat to the left. The small fan-palm in the foreground is *Livistonia mariae* from Australia. The taller palm at the left with coarse pinnae is *Wallichia disticha* a native of northern India. Behind the Wallichia a young Denea, in front a cycad.

are compound, even the first leaves having separate segments. The Denea seedlings usually produce four of the simple leaves before the compound leaves begin to appear, while the first leaf of Howea usually has four segments and the others more.

The second leaf of Howea often has only 4 segments, like the first, but usually 5, 6 or 7, and the number of segments increases gradually in the successive leaves. In the leaves of a typical seedling the following numbers of segments were counted: 4, 7, 8, 9, 13, 15. One plant of Howea was found with a first leaf divided into 6 segments, the count of segments in this individual being 6, 7, 8, 9, 11, 14. A third leaf was noted with 10 segments, 5 on each side.*

A series of variations was selected and photographed at the nursery of Mr. Gustav Teufel, at National City, California, near San Diego, where thousands of the young palms were being raised. Mr. Teufel had observed that the seedlings of *forsteriana* viewed in masses in his propagating sheds have a deeper green foliage than the *belmorcana* seedlings. (Figures 18 and 19).

Several plants of *forsteriana* with the petioles and rachis distinctly reddish and the leaves very dark green, were pointed out by Mr. Teufel, who stated that such plants occur in very small numbers, about one in 200 of the normal green form. Red petioles are found more frequently in seedlings of *belmorcana*, but are not a constant feature as some writers have supposed.

Some of the young plants hold the petiole and rachis more erect, while others are more spreading, with the rachis more oblique, or even horizontal and drooping at the end. Several albino seedlings of *forsteriana* had been separated by Mr. Teufel. One of the plants had the first leaf white, while the second was becoming greenish. Another plant had leaves with alternating white and green stripes. Some of the pale-leaved seedlings do not survive, while others produce successively greener leaves, and eventually appear normal.

Native Habits of Kentias

Adaptations of the two commercial Kentias to different soils have been reported by two observers, but are denied by the most recent writer on the flora of Lord Howe Island. Etheridge, in 1889† stated very definitely that *Kentia forsteriana* was confined to the coral sands, and *Kentia belmorcana* to volcanic soils.

> A very remarkable fact in connection with the two lowland species, *K. Fosteriana* and *K. Belmorcana*, and one I have not hitherto seen mentioned, is worthy of record, and has a bearing on the geology of the island. Wherever the soil is derived from the decomposition of the coral-sand rock, the Thatch Palm (*K. Forsteriana*) exclusively prevails, whilst the appearance of the Curly Palm at once indicates a volcanic soil. So marked and constant is the position of the two palms, that it may be taken in a general way as an index to the running of geological boundaries between the two formations.

The reported difference in soil requirements was confirmed by Maiden

*In rare cases the first leaf of Howea, or even the first two leaves, may be simple as in Denea, so that the possibility of hybridism is suggested, although in Denea the separation of segments usually does not occur until the fifth leaf. Thus it appears that the variations do not form a single connecting series, but two divergent series. The more primitive character of simple seedling leaves has been eliminated almost entirely in Howea, while in Denea the simple-leaf character is retained and even extended to more leaves than usual.

The fifth leaf of Denea usually has 4 or 5 divisions but varies from 3 to 6. In some plants the third or fourth leaves may be unequally 3-parted, while in others the lobes of the first leaf do not separate, so that the leaf appears to be entire. The seedling leaves of Denea attain a length of 23 centimeters with the lobes 4.5 cm. wide. The separate segments of Howea have a width of 2 centimeters or less, and in narrow-leaved individuals may be only 5 to 7 millimeters wide.

†Etheridge, R. The General Zoology of Lord Howe Island, from *Memoirs. Australian Museum*, II, 1889. *Lord Howe Island*, p. 6.

Figure 23 A group of palms on the Gillepsie Estate, Montecito, California, showing similarity and contrasts of foliage characters. Denea at the right, a young Loroma near the center, and a small Eora somewhat to the left. The small fan-palm in the foreground is *Livistonia mariae* from Australia. The taller palm at the left with coarse pinnae is *Wallichia disticha* a native of northern India. Behind the Wallichia a young Denea, in front a cycad.

AUSTRALIAN PALMS IN CALIFORNIA

Figure 24

Terrace at the Gillespie Estate, Montecito, California, near Santa Barbara. Six palms representing two genera, numbers 1, 4 and 5, from the left, Archontophoenix, the others Loroma. Note the long sheathing leaf bases and the large, compound slender-branched inflorescences, in comparison with those of Denea and Howea. The trunks of Loroma are smaller but the inflorescences are larger, and the flowers are purple instead of white.

in 1898, but in 1916* was denied by Oliver in direct terms:

> It has been recorded (Etheridge, *Mem. Austr. Mus.* ii, 6, 1889), that "Wherever the soil is derived from the decomposition of the coral-sand rock the thatch-palm (*K. Forsteriana*) exclusively prevails whilst the appearance of the curly palm (*K. Belmoreana*) at once indicates a volcanic soil." Maiden also (*Proc. Linn. Soc. N.S.W.* 23, 138, 1898) states that *H. Belmoreana* will not grow on the coral-sandy ground; it is always found on basalt. I paid particular attention to the distribution of the two species of Howea in Lord Howe Island, and consider there is no foundation in fact for the above-quoted statements. *Howea Belmoreana* is common enough in places on the sandy flats, though not nearly so abundant there as *H. Forsteriana*. Conversely, *H. Belmoreana* is the dominant palm on the mountain-slopes up to 300 m., though *H. Forsteriana* on the northern slopes of Mount Lidgbird ascends to that height.

While it seems clear from this statement that the habits of the palms in relation to the soil are less specialized than the previous observers supposed, differences may exist that should be recognized in the choice of locations and the treatment that should be given in California. Experiments will be needed to determine the nature and extent of such differences.

Apart from the soil differences which Oliver denies, it appears that *forsteriana* thrives better at the sea-level or low-land conditions, and this accords with the fact that *forsteriana* is much more frequent than *belmoreana* in California. Probably it will be found that *belmoreana* is somewhat more tender and that more sheltered situations should be chosen in order to grow good specimens.

Effects of local conditions in determining the heights of the palms are recognized by Etheridge. A statement is quoted from Moore that the Thatch and Curly palms "both grow to about the same height, the highest observed being about 35 feet," and Etheridge continues as follows:

> In favourable situations, however, these trees attain to a much greater stature than thirty-five feet. I was conducted by Capt. Nichols, a resident, to the "Valley of the Shadow of Death," a gully on the eastern side of the island, running down to Middle Beach, where the finest palms are to be seen. Here the Thatch Palm grows with clean, straight stems to heights of 60, 70, and in a few instances to as much as 100 feet, the overlapping leaves forming a complete canopy above, producing a general gloom, well expressed by the name conferred on the ravine.†

Another locality where the palms grow large was reported by Maiden in 1898‡, with the diameter of the trunk and other data not previously noted:

> *Thatch Palm.*—The leaves of *K. Forsteriana* are, as is well known, used for thatching purposes; the stems, cut to four, were at one time largely used for battens, but now they are rarely put to such use as the trees are too valuable as seed-yielders.
>
> The largest trees of this species are on the Boat Harbour flats on the southeast side of the island. There they attain a diameter of 18 inches or 2 feet and a height of 60 ft. This species grows in belts all over the island.
>
> This and the other two palms (the Curly Palm alone excepted) take twelve months to mature the seeds after the flower appears. The seeds of the Curly Palm are greenish-black when ripe; those of the other three species are red.
>
> *Curly Palm.*—*Kentia Belmoreana* will not grow on the coral-sandy ground; it is always found on basalt. This species takes three years to fully mature its seeds after the flower appears.

Maiden also describes the operation of collecting the seeds by climbing the palms, breaking off the inflorescences and bringing them down, picking off the seeds and carrying them to the coast in back-loads.

No statement has been found to show when the commercial exploitation of the Kentia seeds began. An adver-

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*Oliver, W. R. B. 1917. The Vegetation and Flora of Lord Howe Island. *Trans. & Proc. of the New Zealand Institute for the Year* 1916, issued Dec. 20, 1917.

†*Op. cit.*

‡*Proceedings of the Linnean Society of New South Wales*, Vol. XXIII, 1898. "Vegetation of Lord Howe Island," by J. H. Maiden. Pp. 137 to 140.

FRUITING HABITS OF DENEA

Figure 25

The inflorescences of *Denea forsteriana* are compound, usually with 3 to 5 simple branches inserted on a short basal joint. Each of the branches is sheathed separately in a long cylindrical spathe that forms a complete cover until the flowers project from the surface. The inflorescences are produced in the axils of the living leaves, but persist till the leaves fall off, and sometimes till much later. The retention of the inflorescences for several years, as shown in the third photograph, is a remarkable feature.

tisement in the *Gardeners' Chronicle* for July 2, 1898, announced the arrival of a shipment of 610,000 Kentia seeds as the "grandest consignment received for some years, and well worth the attention of the trade." On November 12 of the same year 122,500 seeds of *Kentia forsteriana* and 136,000 of *Kentia belmoreana* were offered, and on December 17 another lot of 448,000 seeds of *belmoreana*, 50,000 of *forsteriana* and 8,000 of *canterburyana*. Even larger quantities were announced in the early months of 1899, one of 975,000 seeds of *Kentia belmoreana* on January 21. In the course of the year it appears that about four million Kentia seeds were auctioned on the London market.

Palms Confused with Kentias

Two palms that may be mistaken for Kentia are Loroma and Archontophoenix, natives of Queensland, which also flower and fruit in the open air in the coast districts of California. Loroma is much more frequent than Kentia around San Diego and Santa Barbara, and there are fine specimens of Loroma at Los Angeles and Pasadena, where Kentia apparently does not grow, or possibly has not been planted. (Figures 22, 23, 24).

The leaves of Loroma are not recurved or drooping as in the Kentias and the trunk develops more rapidly, with longer and more regular internodes. The inflorescence is entirely different from either of the Kentias, having the form of a large tassel of slender pendent branches, covered at first with light purple flowers, and later with small scarlet berries. An excellent illustration of Loroma appeared in the *Gardeners' Chronicle* for November 8, 1890, on page 533, but wrongly identified as "Howeia (Kentia) Forsteriana." The suggestion of Drudge (on page 734 of the same volume), that this illustration might represent *Kentia canterburyana*, may also be disregarded.

A difference in fruiting habits is indicated by the behavior of Kentias and Loromas in the large slat-house at Balboa Park, San Diego. The Kentias grow as large or larger than in the open, but are not fruiting, while the Loromas fruit regularly in the slat-house, though the inflorescences are smaller and with shorter branches than on the outdoor palms.

Loroma and Archontophoenix are often referred to another related genus, Seaforthia, but the true Seaforthia is a much smaller palm, with the seeds longitudinally grooved and ridged as in Ptychosperma. No examples of Seaforthia have been seen in the open in California, though it is often planted in southern Florida. Archontophoenix and Loroma also thrive in Florida, while the Kentias apparently do not, except in slat-houses or if otherwise shaded. The largest outdoor specimen of *forsteriana* seen in Florida was at Fort Myers, in a protected angle of a large hotel. The leaves were luxuriant, but with no indication of fruiting. Large thrifty specimens at Palm Beach are kept in tubs, used as hotel decorations in winter, and placed in slat-houses in the summer.

In greenhouse practice in the North the Kentias are supposed to have a resting period from November to March, and are carried at a temperature of about 60 degrees. It is reported that stocks held at 50 degrees remained in a healthy condition, and could be placed closer together than during the summer season when the plants are growing.*

Another open-air species in California is the New Zealand palm, *Eora sapida*, which has fruited at Santa Barbara and at Coronado. In some respects the New Zealand palm is intermediate between Loroma and the Kentias, though easily distinguished. The inflorescence is branched, but shorter than in the other genera, the trunk is short-jointed, and the leaf-

Figure 25

The inflorescences of *Denea forsteriana* are compound, usually with 3 to 5 simple branches inserted on a short basal joint. Each of the branches is sheathed separately in a long cylindrical spathe that forms a complete cover until the flowers project from the surface. The inflorescences are produced in the axils of the living leaves, but persist till the leaves fall off, and sometimes till many of the inflorescences for several years, as shown in the third photograph, is a remarkable feature.

The American Florist, July 6, 1918, p. 1202

base bundle is short and bulged in the middle. The most striking contrast with the other genera is that the leaf-blades of Eora do not take horizontal or drooping positions, but remain upright or strongly ascending, which suggested the Greek derivation of the generic name, meaning borne aloft, or uplifted. (Figure 22).

Probably Eora can be grown with the Kentias in places along the coast where it is cool and moist. Shaded northside corners where there is too little space for more spreading types of palms might afford the best conditions for Eora. Palms in the slat-house at Balboa Park, San Diego, are larger and more robust than an open-air plant at Coronado, but are not fruiting. Apparently the outdoor conditions are more congenial than the slat-house conditions, for a normal development of the palm, although the foliage may suffer in the open, by the drying of the ends of the pinnae. The trunk grows 40 feet high in New Zealand. Fruiting has begun about three feet from the ground on the outdoor specimen at Coronado.

Other Coast Palms

The latitude of Lord Howe Island is 32 degrees, corresponding nearly to San Diego, so that the ability of the Kentias to grow on the coast of California is not surprising. The Canary Island date palm (*Phoenix canariensis*) is another insular species that comes from nearly the same latitude in the Atlantic Ocean, and thrives remarkably in southern California. Though not confined to the coast districts, it is there that the Canary palm attains its most complete and majestic development. The true date palm (*Phoenix dactylifera*) and several smaller species of Phoenix are also planted, but thrive better away from the coast.

A palm with habits more like the Kentias, in being restricted to the coast belt in California, is *Erythea edulis,* which may be considered as a native species, since it comes from Guadeloupe Island, off Lower California. The Guadeloupe palm is one of the most beautiful in the coast districts. It is often planted away from the coast but does not thrive or produce fruit in the interior valleys. The Kentias are confined more definitely to the coast and apparently require even less heat than Erythea.

The two species of Washingtonia are not alike in their reactions to the coast conditions. The finest examples of *Washingtonia robusta,* which comes from Lower California, are in the Coast districts. The other species, *Washingtonia filifera*, a native of the hot desert country around Indio, does not thrive so well on the coast. In the coast districts of southern California, *Washingtonia filifera* is generally attacked by a parasitic fungus, while *Washingtonia robusta* appears to be entirely immune.

In comparison with the Washingtonias or the Canary date, the Kentias are small and rather delicate palms, though apparently they do not require special shelter or protection from the sun in the coast districts. Away from the coast, protection from heat may be needed, as well as from cold. Places that are well shaded should be chosen with northern or western exposures, rather than eastern or southern. The Kentias are tolerant of shade, though not requiring shade along the coast and perhaps needing the full sunlight in order to receive sufficient heat for growing rapidly. Some of the finest specimens are growing in lawns around San Diego, and especially at Coronado, between the Bay and the Ocean. How far to the northward it may be possible to grow Kentias, in sheltered places along the coast, is still undetermined.

Localized Distributions of Palms

It is plain from the world-wide distribution of the palms that the biological history of the group must go back to remote periods when the land-masses of the globe were differ-

ently placed, and climatic conditions were different from those of the present. Palm fossils are known from many extra-tropical localities, including Greenland and Alaska. Even in tropical regions many of the palms have localized distributions because they are unable to compete with other types of vegetation that grow more rapidly.

A few of the palms are specialized as shade plants, so that they can live as undergrowth in tropical forests, but many are intolerant of shade and are restricted to open places that are too wet, too dry or too rocky for a dense growth of forest. The adaptive characters are more numerous and the specializations have been carried farther than most of the botanical writers have recognized.

Gradual restriction and localization of the palms no doubt have been going on in the tropics during the more recent geological periods in which the many woody types of forest vegetation have developed. No doubt the wealth of trees has crowded out the palms to a great extent in the continental areas, while island palms had better chances of survival. In this way it is possible to understand why so large a proportion of the palms, not only the species but many of the genera, are not found on the continents, but only on the islands. Moreover the insular species include some of the most striking and peculiar members of the whole order of palms.

Agricultural Research and Extension

AGRICULTURAL experiment stations throughout the country are at work on the problem of making Mother Earth yield and continue to yield more and better products for the support of a growing population. This task is organized in 5,484 experimental and research projects. There is no geographical boundary to the benefits of agricultural research.

No person, whether he lives in Kansas, New Mexico, New York, Wisconsin, or in any other state, can say with reason that he has derived no benefit from the discovery of the Babcock test which revolutionized the dairy industry, or from the perfection of hog cholera vaccine and the black leg vaccine which have greatly reduced losses to the animal industry, or from improvements in crop and livestock production. All of these discoveries and countless others have provided and are providing the people with cheaper and better food and fiber and are beneficial both to producers and consumers.

Extension work and vocational education in agriculture are nation-wide projects to make the fruits of research public property in the widest sense. Through these and other means of education, the truths discovered in the laboratory, in feed lots and on experiment station fields become convincing and are gradually made vital principles of action in agriculture and rural life.

Self-help with guidance is the basic principle of instruction on which the whole plan of agricultural extension is based. This principle is applied through an extensive system of community organization. Aside from the benefits of better farming and better home making, these activities teach people to work together and make them more neighborly and better social beings. Because of the vital relation of agriculture to national prosperity and the place of the rural population in our social structure, these activities are a rising force in our national life and progress.—

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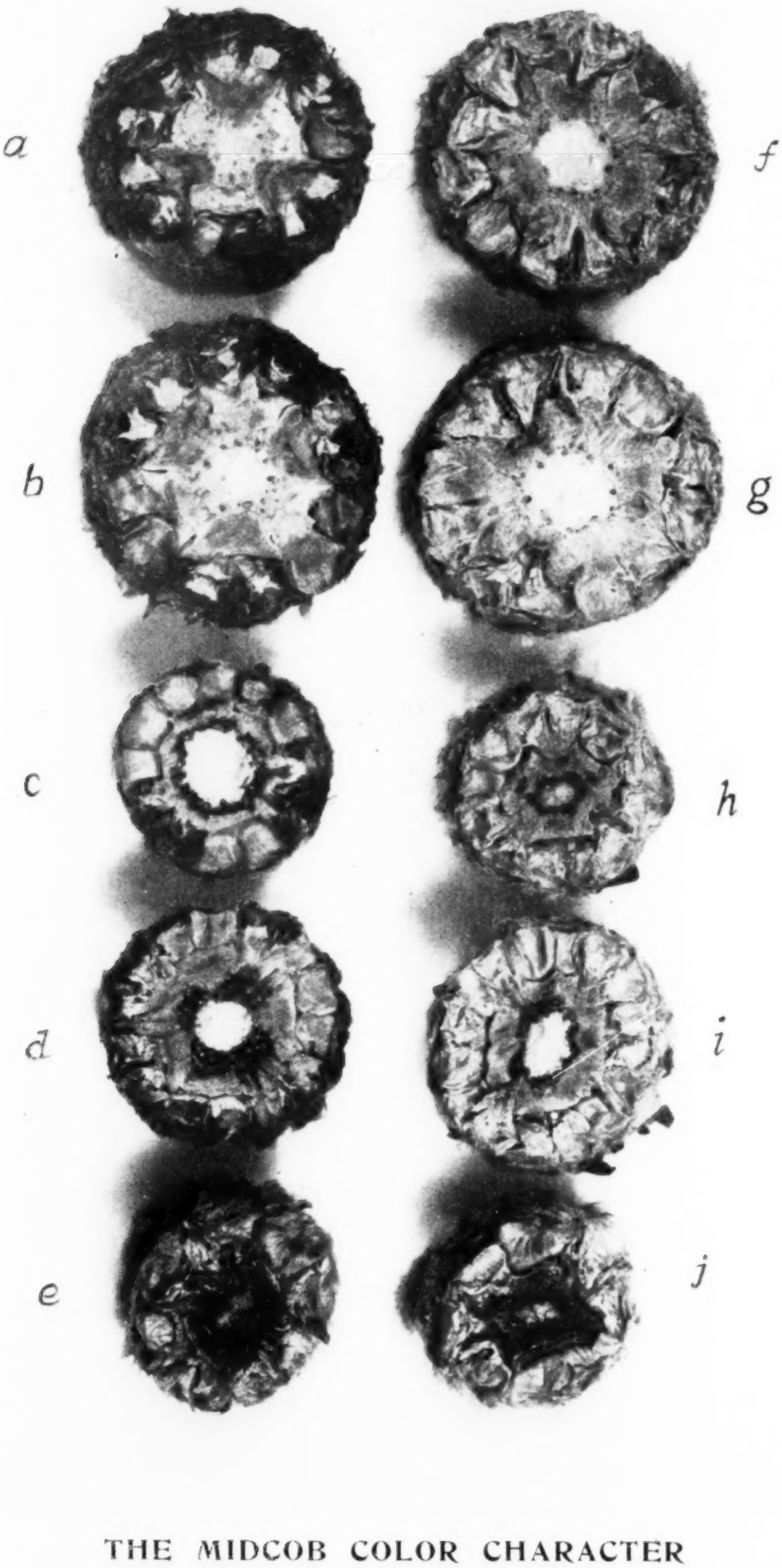

THE MIDCOB COLOR CHARACTER

Figure 26

The colored ring noticeable around the pit on the transverse section of the cob was found to be a heritable character inherited independently of the color of the cob. *a*, *b*: colored cob, colorless midcob; *c*, *d*: colored cob and midcob; *f*, *g*: colorless cob and midcob; *e*, *h*, *i*, *j*: colorless cob, colored midcob.

HERITABLE CHARACTERS OF MAIZE

XXIX Midcob Color

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WHEN breaking off empty parts of the ears used in genetic studies on maize it was noticed that some of the cobs had a colored ring around the pit and others had not. The notes taken on the available material indicated that the presence or the absence of a colored ring might be determined by a Mendelian factor. Subsequent breeding tests supported the indication obtained in the preliminary observations.

Description of the Character

An examination of a transverse section of a cob of maize reveals that the middle region, the "pit," consists of large, thin-walled parenchyma cells. The "pit" is surrounded by a cortex-like region of smaller cells with thicker walls, among which the vascular bundles are embedded. The cortex-like region is the place of origin of the spikelets.

As can be seen from Figure 26, the pigment of the midcob color is limited to the cells surrounding the vascular bundles. Frequently the color extends to the outer layers of the "pit" cells, but no case was observed where all the "pit" was colored. The color varies in different families from light pink, red, or carmine red, to dark sepia brown. The last color was observed frequently among the offspring of teosinte-maize crosses.

Inheritance

This midcob color was found to be a simple Mendelian dominant to the colorless condition. In the F_2 generation from crosses between colored and colorless, 294 plants with colored midcobs and 106 colorless offspring were obtained. The difference from the expected 3:1 ratio was 1.5 ± 5.8. The backcrosses gave 234 with colored and 225 with colorless midcobs, a difference from expectancy of 4.5 ± 7.29.

As already mentioned, several different midcob colors were found in different families. The progeny from red, carmine red and sepia midcobs all resembled the parent types, indicating that these differences in color are heritable. This indication is supported by the F_2 results, which can be summarized as follows:

Parents	*F_2 Offspring*
Red × White	175 Red, 58 White
Carmine × White	45 Carmine, 15 White
Sepia × White	17 Sepia, 5 White
Sepia × Red	60 Sepia, 21 Red

In two related families the segregation was observed of a type which was called "variegated midcob." These two families gave 35 red, 11 variegated and 2 white midcobs. The colored ring of the variegated midcob is not complete, as it is the case in the other types, but is interrupted with white tissue in one or several places. In several cases of variegated midcob which were closely examined, the pattern of the midcob ring was found to be different on different sections of the same cob.

From the results of the experiments so far made, no conclusion could be reached as to whether the different midcob colors are determined by a series of allelomorphs or whether they are determined by unrelated factors.

Relation Between the Midcob and Cob Colors

The data obtained by Anderson[1] indicated that a series of cob and pericarp colors ranging from orange red

to red as well as variegation patterns are determined by a series of allelomorphs. Since the red midcob color closely resembles the red cob and pericarp color, it was of interest to ascertain the genetic relation between these two characters. The data of the backcrosses involving white and red cob color and white and red midcob color are given in Table I. They indicate that midcob color is inherited independently from the cob color.

Anderson and Emerson[2] showed that the factor *A-a* when recessive (*a a*) changes the red pericarp color to the brown. The recessive *a a* does not produce such a change in the case of midcob color. A family having brown cobs had red midcobs.

Summary

Midcob color (*Md-md*) is a character which is expressed by a colored ring around the "pit" of the cob. Light pink, red, carmine red and dark sepia colors were observed in different families.

The color is inherited as a simple Mendelian dominant to the non-colored condition.

Midcob color is inherited independently of cob color. It is not changed to brown by the recessive *a a* factor as in the case of cob color.

TABLE I—Back-cross data involving red and white midcobs and red and white cob colors

Pedigree No.	*Red md*		*White md*	
	red cob	*wh. cob*	*red cob*	*wh. cob*
1328	17	11	12	15
1329	14	13	14	12
1330	15	15	20	17
1331	16	18	16	16
1332	14	17	17	19
1333	11	16	7	12
1334	15	16	14	13
1335	16	10	12	14
Total	118	116	112	118
Calculated 1:1:1:1	116	116	116	116
Difference	+2	—	—4	+2

Literature Cited

1. Anderson, E. G. Pericarp studies in maize. II. The allelomorphism of a series of factors for pericarp color. *Genetics*, 9:442-453. 1924.

2. Anderson, E. G., and R. A. Emerson. Pericarp studies in maize. I. The inheritance of pericarp colors. *Genetics*, 8:466-476. 1923.

Peyote Intoxication

Der Meskalinrausch, seine Geschichte und Erscheinungsweise, *by* Kurt Beringer. Pp. 315, price M. 18. (Monographein aus dem Gesamtgebiet der Neurologie und Psychiatrie, Heft 49). Berlin. Verlag von Julius Springer, 1927.

The famous mescal button, a narcotic widely used by Mexican and American Indians, was determined by W. E. Safford, in an articles published in the Journal of Heredity, VI: 291-310 (July, 1915) to be a cactus, *Lophophora williamsii*. A German psychiatrist has studied the effects of it extensively, a large part of the book being taken up with the record of the experiences of 32 persons who took the drug. It is a valuable contribution to an interesting and important subject.

—*P. P.*